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DIFFERENTIAL ACHIEVEMENT, ABILITY PROFILES, AND FIELD DEPENDENCE

BY

© DAVID W. ROWE

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF EDUCATION

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

EDMONTON, ALBERTA
FALL 1986

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled ACHIEVEMENT DIFFERENTIAL, ABILITY PROFILES, AND FIELD DEPENDENCE submitted by David W Rowe in partial fulfilment of the requirements for the degree of Master of Education.

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Date: August 11, 1986

ABSTRACT

This study of over 200 Grade 8 and 9 students investigates two primary questions. The first is whether there are subgroups of learning disabled children who may be separated from the larger heterogeneous learning disabled population on the basis of whether certain achievement strengths or deficits will be reflected in their WISC-R profiles and, as a corollary, whether those profiles will facilitate differential diagnoses of homogeneous subgroups of learning disabilities. The second question examines the role of cognitive style, as manifest in field dependence-field independence construct, in diagnosing learning disabilities.

The study identifies five WISC-R profiles of subgroups learning disabled children. Some, though not all, of the profiles may have practical diagnostic value. Field dependence emerges as a major factor in achievement. The apparent paradox of high field independence scores for both high achievers and many groups of exceptional children suggests the possibility of a category of "pseudo-field independence." The results suggest that assessment of field dependence should be a part of a standard paycho-educational assessment.

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CHAPTER 1

INTRODUCTION

Since the inception of the Wechsler Scales in the Wechsler Bellevue, researchers have sought in those scales a profile that would identify learning disabled children and adults. Because the scales report scores for several facets of intelligence, it seems intuitively correct that there should be found a profile which will show how learning disabled individuals differ from those individuals in the population who learn at a rate which seems consistent with their measured abilities. So attractive is the idea that there should be some difference in the profiles of a learning disabled child and a normally achieving child that psychologists and educators have continued to search for a profile despite many studies and little consistent evidence that such a profile exists.

While a consistent profile which appears at statistically significant levels and which will discriminate learning disabled from non-disabled has not been found, there are general patterns in the Wechsler scores which recur time and time again. As a group, learning disabled students tend to show performance scores on the Wechsler Scales which are higher than their verbal scores. And, as a group, they, along with other exceptional groups, tend to show their greatest strength on those scores which are most directly linked to spatial ability; namely, Picture Completion, Block Design, and Object Assembly. Spatial ability, in turn, and the three subtests listed have been shown by Goodenough and Karp (1961) to be associated with psychological differentiation, that is, the field independence pole of the field dependence-field independence continuum. This association suggests a paradox or at least an apparent paradox. The research in learning disabilities shows that learning disabled, mentally retarded, emotionally disordered, and others exhibiting learning difficulties receive their highest scores on the tests associated with field independence. Research in field dependence shows that field independent persons tend to be high achievers. Hence the paradox: two groups tend to score high relative to personal means on the spatial trio of the Wechsler Scales, one group representing underachievers and the other representing successful achievers.

This study addresses two problems: one, the problem of Wechsler Intelligence Scale for Children--Revised (WISC-R) profiles for learning disabled (LD) children, and two, the relation of field dependence-field independence to achievement and to the type of WISC-R profile exhibited.

It seems demonstrable that there is no single profile for all learning disabled children. In a sense the question is specious as few serious researchers in the field have held that that there is but one type of learning disability. Learning disabilities have been attributed to variously minimal brain dysfunction, differential maturation of the cerebral hemispheres, problems with auditory perception, problems in visual discrimination, visual motor integration, attentional deficit, impulsivity, and a host of other causes. Given the range of potential etiologies, it seems unlike that there would exist only one profile to be exhibited in the Wechsler Scales.

Leading researchers in psychoeducational assessment (Ryckman,1981; Ryckman & Elrod, 1983; Kaufman, 1979, 1981) have asserted that a continued search for a single WISC-R profile to identify learning disabled children is inappropriate. There is a growing realization that learning disabled children are not a homogeneous group, and that research that deals with them as such is not likely to yield results that contribute to the efficacy of diagnosis. Bannatyne (1968, p. 242) states, "Just as there are hundreds of reasons why a person may be unable to walk, so are there hundreds of discrete causal 'states' which can result in the inability to learn to calculate, read, write or spell well." Ryckman (1981) points out that a major assumption, and a mistaken assumption, underlying much of the work in psycho educational research has been that LD children are a reasonably homogeneous group. Rie and Yeh (1982, p. 28) note that research in learning disabilities has been "hampered" by the failure to attempt to subclassify the learning disabled on the basis of "variables uniquely associated with subtypes of learning disabilities." Kaufman (1981) writes of the need to investigate homogeneous LD populations within the larger group of underachievers. The theme which emerges is not, however, that further research with the WISC-R or for profiles is bound to be fruitless. Indeed what emerges is a call for more research. Ryckman's recommendation (1981, p. 510) is that "a more appropriate approach, especially for the purposes of programming, would be to try to identify relatively homogeneous subgroups of LD children". Kaufman (1981) makes similar recommendations. The challenge to look for those subgroup profiles seems to have gone largely, but not completely, unheeded. Rie and Yeh (1982) made an attempt to discriminate two subgroups of LD children: children with neurocognitive impairment and those without using the Block Design test. They found that the impaired children had lower overall intelligence, and that they were specifically deficient on the Block Design subtest. In a study more closely related to the proposal of this thesis, Ahn (John, Karmel, Corning, Easton, Brown, Ahn, John, Harmony, Prichep, Toro, Gerson, Bartlett, Thatcher, Kaye, Valdes, & Schwartz, 1977) looked at the neurometric--computer quantified analysis of EEG data--profiles of a group of normal and learning disabled children. The LD children were subgrouped according to the effect of their disability by content area, e.g., those defective in language but normal in arithmetic, those with defective arithmetic but normal language, and those defective in both arithmetic and language ability. When ANOVA comparisons were made of the normal children and the LD children significant differences (at the $p \leq .01$ level) were found, but analysis of the subgroups of underachievers revealed that "the three different types of underachievers display three radically and replicably different patterns of deviation from the AER [averaged evoked response] morphology displayed in children with normal learning quotients" (p. 1408). These results strongly suggest that significant differences between groups of LD children do exist, and they hold up the possibility that those differences might be detected through careful analysis of WISC-R or other data if the initial assumption is that there are a variety of WISC-R profiles for learning disabled children, and that those profiles will be discovered by beginning with the analysis of achievement or underachievement in specific content areas.

The initial question this thesis will examine is whether students who have been identified formally or informally as having learning difficulties, and who show levels of achievement on the subsections of the Canadian

Achievemnt Test which are substantially different from their Total Battery scores will exhibit different WISC-R profiles. The Canadian Achievement Test (CAT) reports achievement in Reading, Vocabulary and Comprehension; Language, Mechanics and Expression; Spelling; Mathematics, Computation and Concepts and Application; and Reference Skills as well as a Total Battery Score. The cognitive requirements for each subtest seem sufficiently different that strength or weakness in any subsection relative to an individual's test mean may, in conjunction with strength or weakness on one or more of the remaining subsections, signal a distinctive WISC-R profile. It is expected that distinctive patterns of strength or weakness in the achievement subsections will be associated with distinctive WISC-R profiles. The second question this study will examine is the relationship of the WISC-R and CAT profiles to the field dependence construct.

The second question deals with the paradox of the asssociation of high scores (relative to personal means) on the WISC-R Picture Completion, Block Design, and Object Assembly subtests with field independence and of field independence with high achievers (Kagan & Zahn, 1975; Shade, 1983; Swyter & Michael, 1982; Witkin, Moore, Goodenough, & Cox, 1977); and, in seeming contradiction, the association of those same high scores with learning disabled and other problem learners (Bannatyne, 1974; Bracken, Prasse, & Breen, 1984; Kaufman, 1981; Rourke & Telegdy, 1971; Shah & Frith, 1983; Smith, 1978; Witkin, Faterson, Goodenough, & Birnbaum, 1966). The importance of this triad of subtest scores is shown in both factor analytic studies of Cohen (1959) and Kaufman (1975), where these three subtests form three-fourths of the Perceptual Organization factor, and in clinical experience as expressed in Bannatyne's (1968) recategorization of the Wechsler scales in which the triad forms his Spatial category. The scores also account for three-fifths of the Performance IQ score, and in doing so have a significant role in potential Verbal-Performance IQ differences. The question arises whether there is an association between Verbal-Performance differences and field dependenceindependence? Kaufman (1979) acknowledges the possibility of such a relationship and makes suggestions regarding the investigation of that possibility (p. 41). This study follows, for the most part, his suggestions, but will go on to examine wider implications of cognitive style on other profiles which may be evolved in the course of this investigation. As a subsidiary issue, the study will consider possible relationships between field independence and some subsets of WISC-R subtests which are frequently associated with LD, primarily, the ACID profile and the Third factor.

Finally, the investigation will explore the possibility that interactions between achievement, ability and field dependence can be demonstrated. Such interactions would seem likely on the basis of relationships already noted: WISC-R scores with achievement, WISC-R scores with field dependence, and field dependence with achievement.

In summary, this study will examine the profile of strengths and weakness (relative to the Total Battery score). of student performance on the various subtests of the CAT in an attempt to discover associated WISC-R profiles which may represent relatively homogeneous subgroups of learning disabled children. Secondly, the association of field dependence in learning disabilities will be investigated. And, thirdly, both CAT and WISC-R scores will be compared with Group Embedded Figures Test (GEFT) scores to determine possible influences of cognitive style, as exhibited through the construct of psychological differentiation or field dependence-independence, on the profiles this thesis expects to find.

CHAPTER 2

REVIEW OF THE LITERATURE -- THE SEARCH FOR PROFILES

The Wechsler Intelligence Scale for Children--Revised (WISC-R) like its progenitors, the Wechsler Bellevue Intelligence Scale and the Wechsler Intelligence Scale for Children (WISC) has engendered many studies seeking a profile among the subtest scores that typifies learning disabled children. Those studies have usually taken one of three approaches: to examine differences in Verbal and Performance IQs; to look at the extent of of "subtest scatter"; and to examine the pattern of subtest scores in the hope of finding a pattern that is typical of learning disabled children. The appeal of the Wechsler Scales for the type of research suggested above lies in the fact that the scales examine a number of reasonably discrete facets of intelligence, and it appears that the difference between the learning disabled and normal learners lies not in what may be called general intelligence but in one or more of the abilities which underlie intelligent behavior and especially in those abilities which contribute to achievement in school.

Learning disability most often manifests itself in inadequate school achievement, and it is but rarely that a child is diagnosed as learning disabled before he or she begins some formal educational program. Part of the difficulty in developing a profile of the learning disabled child is in defining what is meant by the term. Sattler (1982) rightly points out that the term "learning disability" has both a broad and a narrow sense (p. 391). In its broad sense the term applies to the failure to learn for almost any reason: mental retardation, emotional disturbance, brain injury, sensory disabilities, and perhaps others. In its narrower sense it refers to children of normal intelligence who have had apparently adequate social and educational opportunity and who fail to achieve at a level commensurate with their measured ability. It is, presumably, with this latter sense of learning disability that the search for Wechsler profiles is concerned; it is to discover why children with no obvious intellectual, sensory, or emotional handicap fail to thrive academically. There are difficulties, however, with this narrower definition, indeed, there seems to be a broader and narrower sense with this definition as well. There seems to be a wide sense of what ought to be meant by "normal intelligence" in which it means "adequate intelligence" in some undefined sense of adequate. In that wide sense not all researchers equate normal intelligence with the Wechsler "Average" intelligence classification (1974, p. 26). Many of those who have examined WISCs and WISC-Rs in attempting to discover some commonalities in learning disabled populations have classified children with IQs in the 80's as learning disabled (Smith, Coleman, Dokecki, & Davis, 1977). Smith and his colleagues asserted that fully 37% of the studies they looked at failed to conform to the most generally agreed upon description of learning disabled children, i.e., that of normal intellectual functioning. Lower ability, that is, IQs in the 70 - 79 (Borderline) range and perhaps in even the 80 - 89 (Low Average or Dull) range seems to represent a different sort of problem than that of children in the 90 - 109 (Average) range or those in the 110 and above ranges who fail to perform at an adequate level of school achievement inasmuch as school achievement is for the most part predicated on the "normal" IQ being an average or above average IQ. The learning disabled population with which this thesis is most concerned is this latter group, those with average or better IQs who do not achieve at an average or better level. This review will, nonetheless, look at studies of the relationship between Wechsler scale profiles and learning disabilities representative of both the wider and narrower senses of learning disability.

FACTOR ANALYTIC STUDIES AND BANNATYNE'S RECATEGORIZATION OF THE WECHSLER SCALES

Factor analysis of the Wechsler Scales has repeatedly found three primary factors: Verbal Comprehension, Perceptual Organization, and a third factor most often labelled Freedom from Distraction (Cohen, 1959; Goodenough & Karp, 1961; Kaufman, 1975; Robinson, 1982). The Verbal

Comprehension factor consists of Information, Similarities, Vocabulary, and Comprehension. Picture Completion, Picture Arrangement, Block Design, Object Assembly, and Mazes make up the Perceptual Organization factor. The third factor, Freedom From Distraction, is constituted from the Arithmetic, Digit Span, and Coding subtests. A body of research indicates these factors hold constant across a range of populations--males, females, blacks, whites, Native Americans, Chicanos, mentally retarded, learning disabled, and emotionally disturbed (Kaufman, 1979).

The Verbal Comprehension and the Perceptual Organization factors support the division of the test into major divisions with different common factors underlying both. Four of the five subtests added to obtain the IQ score for the Verbal Scale are found to load substantially on the Verbal Comprehension factor, and four of the five subtests of the Performance Scale load substantially on the Perceptual Organization factor. There seems little question that the two major divisions of the Wechsler Scales rest on (1) the ability to understand and use language, and (2) the ability to make sense of and give meaning to the visual world through nonverbal processes.

The third factor is more problematic. Kaufman (1975) labels the factor Freedom from Distractibility implying an underlying common variable of attention, or perhaps more precisely, selective attention and concentration. Sattler (1982) observes that numerical ability may contribute to this factor. Each of the subtests involves the manipulation of numbers or number-like symbols as opposed to words or images. Short-term memory may have an influence as well. Bannatyne (1968) categorized the underlying variable as the ability to sequentially process both incoming stimuli and response behavior.

Bannatyne's recategorization of the Wechsler scales developed out of his clinical experience with the WISC and disabled readers and not though factor analysis (1968; 1974). The recategorization developed with the WISC has been found to apply equally well with the WISC-R. While his recategorization yields four categories rather than three factors, his categories, with one exception, tend to recapitulate, for the most part, the groupings arrived at through factor analysis.

Bannatyne's Verbal Conceptualization Ability category includes Similarities, Vocabulary, and Comprehension. These are the subtests which have the greatest loadings in the Verbal Comprehension factor, and they make up three-fourths of that factor. Similarily, his Spatial Ability category consisting of Picture Completion, Block Design, and Object Assembly is three-fourths of the Perceptual Organization factor and includes the subtests with the heaviest factor loadings. The same common variables as underlie Verbal Comprehension and Perceptual Organization also underlie Verbal Conceptualization and Spatial Ability respectively.

As was indicated in discussion of factor analysis of the Wechsler scales, Bannatyne's Sequencing Ability category is comprised of the same three subtests as load on the Freedom from Distraction factor--Arithmetic, Digit Span, and Coding. The Acquired knowledge category, Bannatyne's fourth grouping, is thought to reflect the child's ability to learn those things which are usually taught in some formal or informal sense at home or at school. The category includes Arithmetic, Information, and Vocabulary. Problem learners usually score poorly on these subtests.

The examination of Bannatyne's recategorization of the WISC and WISC-R subtests concludes the discussion of the Wechsler scales and completes the background required to begin a review of the studies that have sought LD profiles in the Wechsler scales. The review begins with those studies which have evolved out of the factor analytic results discussed in the preceeding material.

LEARNING DISABILITIES AND VERBAL-PERFORMANCE DIFFERENCES

The different factorial structures of the Verbal and Performance scales of the WISC and WISC-R plus the observation that some LD children have higher Performance than Verbal IQs has lead to a number of studies examining the relationship of such differences and learning disability. An even larger number studies have investigated the relationship of learning disabilities and Verbal-Performance discrepancies without regard to which scale yielded the higher score.

A number of studies are summarized in Table 2-1. The summary reflects the general observation that LD children tend to score more highly on the Performance Scale of the WISC/WISC-R than they do on the Verbal Scale. Of 842 children specifically listed as learning disabled in the studies, only a group of 58 did not receive a mean Performance IQ score which exceeded their mean Verbal IQ score. In data gathered for this thesis study, 72% or 156 of 216 students (all of whom have been assessed for learning difficulties) showed higher Performance than Verbal IQs. Forty-eight percent showed a Performance IQ 10 or more points greater than their Verbal IQ. There was no significant difference between males and females. Seventy-three percent of boys in the research group and 71% of girls had P>V IQ scores: 47% of boys and 49% of girls had scores in which P>V was equal to or greater than 10. By way of contrast, in a high IQ - high achievement comparison group from the same schools (N = 31) only 19% showed a Performance

TABLE 2-1
SUMMARY OF STUDIES REPORTING PERFORMANCE AND VERBAL IQS AND WISC-R SUBTEST SCORES WITH DIFFERENT SAMPLE POPULATIONS OF LEARNERS. FOUR LOWEST AND FOUR HIGHEST RANKING SUBTESTS LISTED FOR EACH GROUP.

AUTHOR(S) DATE)	POP.	(N/X̄ AGE)	MEAN FSIQ/SD	MEAN VIQ/SD	MEAN PIQ/SD	DIFF. P > V	LOWEST (4) SS (LO-HI)	HIGHEST (4) SS (HI-LO)
Anderson et al. (1976)	LD	(41/9-11)	84.0/15.0	82.0/15.6	89.0/15.5	7	S,I,V,A	PC,C,[Mz][a] AO,PA
Bracken et al. (1983)	LD[1]	(104/[1])	96.2/11.5	92.7/11.8	101.0/14.8	8.3	Ds,A,I,V,(Cd)[b]	OA,PA,PC,BD
	RP[1]	(39/[1])	99.0/12.2	96.2/12.3	102.8/13.6	6.6	Ds, A,I,S,(Cd)	PC,OA-C[c],PA
Corning et al. (1982)	DSF[2]	(36/11-7)	96.1/15.9	92.6/14.6	101.3/17.5	8.7	Ds,I,Cd,V,(A)	PA,PC,PA, [Mz],PC
	NF[2]	(23/11-1)	114.5/13.2	112.1/13.4	113.8/12.4	1.7	Cd,Ds,[Mz],A,I	OA,C,BD,PA
Henry & Wittman (1981)	LD	(40/[3])	83.1/11.2	84.3/ 9.3	84.9/14.4	0.6	Ds,A-Cd,I	PC,OA,C,S
	LD	(40/[3])	90.6/11.0	89.1/13.1	94.9/15.0	5.8	I,Ds,A,Cd	PS.PA,OA,S
	EMH	(40/[3])	63.4/11.0	65.9/ 9.6	66.0/12.1	0.1	PA,I,A,Ds-BD	PS,OS,C,S
	ED	(40/[3])	88.1/12.9	86.5/13.4	90.9/15.4	4.4	Cd,A,Ds,I	OA,PC,PA,S
	GIFTED	(40/[3])	129.5/ 9.2	129.1/10.1	123.5/10.9	-5.6	Cd,Ds,A,PC	C,V,S,I
Moore & Wielan (1981)	RR[4]	(434/[5])	95.4/13.1	94.1/14.7	97.9/14.7	3.8	Ds,Cd,A,I-V	PA,PC,OA,C
Smith (1978)	LD	(161/9-6)	85.9/12.3	83.7/12.1	91.6/12.8	7.9	I,A,Cd,V-S[d]	OA,PC,PA,BD
Smith et al. (1977)	LD	(208/9-9)	87.1/12.3	84.8/12.2	92.7/12.9	7.9	I,A,Cd,V[d]	OA,PC,PA,BD
	LD[H][6]	(132/[8])	93.3/10.4	90.1/11.0	99.6/10.1	9.5	I,A,Cd,V[d]	OA,PC,PA,BD
	LD[L][7]	(76/[8])	76.3/ 6.5	75.7/ 7.8	80.5/ 7.0	4.8	I,Cd,A,V-S[d]	OA,PC,BD,PA
Teeter et al. (1982)	NH[9]	(113/[10])	79.1/11.0	66.1/13.6	96.4/12.3	30.3	V,C,I,S	OA,BD,PC,Cd
	ED[9]	(189/[10])	75.0/ 9.4	60.2/ 9.7	94.4/12.1	34.2	V,I,C,S	OA,BD,PC,Cd
	LD[9]	(150/[10])	70.4/11.0	58.2/10.7	87.1/14.6	28.9	V,I,C,S	OA,PC,BD,Cd
Thompson & Brassard (1984)	N[11]	(20/10-2)	102.5/ 9.2	99.5/11.4	105.5/9.9	6.0	NOT GIVEN	
	LD[M]	(20/10-0)	95.2/10.2	92.4/10.8	99.7/12.6	7.4	NOT GIVEN	
	LD[S]	(20/10-0)	95.9/ 8.3	91.0/11.8	102.7/8.0	11.7	NOT GIVEN	
Vance et al. (1976)	LD	(58/10-0)	NA	91.4/10.5	91.1/ 9.7	-0.3	A,Cd,I,BD[d]	OA,PC,C,V

NOTES:

a Because Mazes is omitted in some studies listed, it is bracketed where it appears, and the next highest test is shown to make rankings more comparable.

b Where one of the subtests forming the ACID profile ranks in the fifth place it has been added in parentheses.

c Two subtests of the same rank are joined with a hyphen.

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NOTES — continued —

d Digit Span subtest was not given/reported.

1 RP indicates regular class placement as a result of a multidisciplinary team decision after psychoeducational assessment. The mean age for the total group of 142 students was 11-8. The mean ages for LD and RP as separate groups were not given.

2 DFS indicates diffuse EEG slow frequency; NF indicates normal EEG frequencies at electrode sites compared.

3 Mean age not given. Study reports the sample consisted of 200 children grades 1 - 6.

4 RR designates 'reading referred', i.e., children referred to the University of Georgia Reading Clinic on the basis of a suspected reading disability.

5 Mean age not reported. Study does report that the age range of the children in the sample was from 6 to 16 years and that 68% of the sample was between 7 and 10.

6 High IQ subgroup (LD[H]) of the 208 children involved in the study. High IQ criteria: FSIQ $\geq$ 76 and a VIQ or PIQ $\geq$ 90.

7 Low IQ subgroup (LD[L]) of the 208 children in the study. The Low IQ subgroup consists of those children scoring below the criteria listed in 6.

8 Separate mean ages for high and low IQ groups not given.

9 Participating children were all American Indians (Navajo). NH designates nonhandicapped, ED educationally disadvantaged, and LD learning disabled. All the children had been referred for psychoeducational assessment on the basis of school related difficulties.

10 Mean ages not reported. Study does report that participants ranged in age from 6-0 to 16-10, and that they were in grades 1 through 10.

11 N designates 'normal' indicating achievement appropriate to ability level. The LD students were divided into two groups, Mild to Moderate LD (LD[M]) showing a mean ability-achievement discrepancy of 37%, and Severe LD (LD[S]) with an ability-achievement discrepancy of 54%.

score greater than their Verbal score, and 39% scored 10 or more IQ points higher on the Verbal Scale. These results are comparable to most of those reported in the summary.

Rourke, Young, and Flewelling (1971) studied the relationship between WISC Verbal-Performance differences and a number of abilities (verbal, auditory-perceptual, visual-perceptual, and problem-solving) in learning disabled children. Ninety children between the ages of 9 and 14 with learning disabilities were divided into three groups of 30 each on the basis of their Verbal and Performance IQ scores. The groups were formed on the basis of (1) high performance-low verbal (HP-LV), (2) verbal and performance scores within four points of each other (V = P), and (3) high verbal-low performance (HV-LP). Groups were equated for age and IQ. The groups differed on IQ scores as follows: HP-LV, PIQ = 105.4, VIQ = 88.8, Difference = 16.6; V = P, VIQ = 96.5, PIQ = 96.7, Difference = 0.2; HV-LP, VIQ = 102.6, PIQ = 86.2, Difference = 16.4. Rourke, Young and Flewelling report that, as expected, the HV-LP group was superior to the HP-LV on tasks requiring verbal, language, and auditory-perceptual ability. The HP-LV group, again as expected, showed superior performance on the tasks that primarily required visual-perceptual skills. The V = P group performed at intermediate levels compared to the other two groups. The differences observed between the groups were, with the exception of the PPVT and the Halstead Category Test, significant at or beyond the 0.05 level. Rourke et al. reported that their results "supported the notion that performance on verbal- and language-related tasks such as reading and spelling can be independent of performance on relatively simple motor and psychomotor tasks" and that the results "support the suggestion . . . that, in older children, the VIQ-PIQ relationship is a more important consideration with regard to reading difficulties than is general level of intelligence" (p. 478). They conclude that WISC verbal-performance differences can "rather consistently" predict differential performance on a wide variety of ability tests used with LD children. The implication seems clear: Verbal IQ-Performance IQ discrepancies reflect differences not just in achievement but differences in abilities.

In 1973 Rourke, Dietrich, and Young repeated the above procedures with a group of younger children. Eighty-two children 5 to 8 years-old and exhibiting learning disabilities participated. In this case the results did not "yield the same clear cut differences" but did show tendencies in the same directions. As a result Rourke and his colleagues cautioned against overinterpretation of WISC profiles for younger children.

Moore and Wielan (1981) studied verbal-performance IQ discrepancies in 434 children who had been referred to the University of Georgia Reading Clinic for diagnosis of suspected reading disability. The children, 310 boys and 124 girls, ranged in age from 6 to 16 years but most of them (68%) were between 7 and 10 years. When sign was not taken into account, the mean discrepancy between verbal and performance IQs was 11.2 points, and 42% of the group had a difference of 12 or more points. They point out that the difference is significantly greater ($\underline{p}<.01$) than the difference found in the WISC-R standardization sample. When sign was considered, 40% of the sample showed greater Verbal IQs than Performance IQs, and 57% exhibited greater Performance IQs. The mean difference between IQ scores when

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V>P was 9.3 (SD = 6.5); the mean P>V discrepancy was 13.1 (SD = 8.8). Statistical comparisons indicate that the mean P>V discrepancy is significantly higher ($p<.01$) than the mean V>P discrepancy. Moore and Wielan note that despite the fact that the differences are statistically significant, the magnitude of difference is quite small when compared to the standardization sample. They comment that the "mean differences are not large enough to be meaningful in a practical sense" (p. 511).

It should be noted, however, that not all children included in the Moore-Wielan study were reading or, presumably, otherwise learning disabled. The authors kept all students referred to the Reading Clinic in the study whether they were diagnosed reading disabled or not, and there is no comment regarding the proportion of the sample that was judged not reading disabled. It is conceivable that if those children who were ~~not~~ diagnosed as reading disabled were excluded, the size of the differences may have had greater practical significance. The foregoing observation notwithstanding, in the standardization sample the percentage of cases in which V>P and P>V reached significant levels was approximately equal (16% vs. 18%), but in the Moore-Wielan study the percentage of cases in which P>V was slightly more than twice that in which V>P (28% vs. 13%).

In examining the proposition that the WISC-R measures children's learning proficiency, Raymond Dean (1983) studied a learning disabled group of 60 Caucasian children whose mean age was 10.76 years. Dean's primary interest was to evaluate the WISC-R's efficacy as a predictor of performance on a non-verbal learning task; in the course of that research, he provided the Performance and Verbal IQ scores of his learning disabled sample. The mean Performance IQ score for the group was 89.9 which is significantly ($p<.001$) larger than the mean Verbal IQ of 80.1. He suggests that LD "children seem to experience more success on tasks that require immediate problem-solving ability and lack the structure of the verbal subtests" (p. 439). He indicates that his research provides empirical support for the clinical observation that, as a group, children with learning disabilities display greater variability of performance on the WISC-R than do normally achieving children. With regard to the primary goal of his study, Dean found that Coding was the single best predictor of the rate and accuracy of non-verbal learning and that it accounted for approximately 55% of the variance in subject performance.

Not all investigators of the relationship between WISC or WISC-R scores and learning disabilities find significant differences. Vance, Gaynor, and Coleman (1976), despite opening their report with remarks to the effect that studies investigating LD had found a relatively well established pattern of low performance and high verbal and/or low verbal and high performance scores, found no such pattern in their investigation. Working in rural North Carolina with 42 LD boys and 16 LD girls (age range 6-0 to 15-10; mean age 10 years), Vance and his co-researchers recorded a mean Verbal IQ of 91.4 (SD 10.5) and a mean Performance IQ of 91.1 (SD 9.7). Such a difference is significant neither statistically nor practically.

A more frequent result is show in a study by Anderson, Kaufman, and Kaufman in the same year. Anderson and the Kaufmans studied a group of 41 children diagnosed as having specific learning disabilities. The group whose mean age was 9-11 (age range 6-1 to 15-7) included 29 boys and 12 girls. The sample was racially mixed: 18 whites and 23 non-whites "such as Japanese and Hawaiian" (p. 381). The mean VIQ and mean PIQ for the LD group were, respectively, 82.0 (SD 15.6) and 89.0 (SD 15.5). When the mean verbal-performance discrepancies were calculated without regard to sign, the LD group mean was 12.5. Compared to a group of normally achieving students who showed a mean V-P discrepancy of 9.7 IQ points (regardless of sign), the LD group is significantly more discrepant ($p<.05$). The importance of the differences is reduced in practical (diagnostic) terms when the authors point out that 31% of normal children display a V-P difference of 12.5 or more points. Hence while statistical differences are obtained between verbal and performance scores of LD and normal learners, those scores alone are not diagnostic of a learning disability. There is considerable overlap between the verbal-performance discrepancies manifest by LD children and discrepancies shown by normal children.

Not only do differences in verbal-performance scores obtained on the Wechsler Scales fail to distinguish LD children from children who achieve at their expected level, the differences fail to distinguish LD children from some other exceptional groups. Rie and Yeh (1982) compared WISC Verbal and Performance scores for 31 neurocognitively impaired and 31 intact children. The intact children's verbal and performance scores correlated at the .56 level, while the impaired group showed only a .13 correlation. In a 1970 British study, Lockyer and Rutter conducted a five- to fifteen-year follow-up study of children with infantile psychosis. Compared to a group of children with non-psychotic disorders, more children who had suffered childhood psychosis had higher Performance Scale scores and more of the non-psychotic children had higher Verbal Scale scores. Here, again, there was considerable overlap: only 19 of 30 psychotic children showed a higher Performance Scale score, and in the control group the proportion receiving a higher Verbal score was 27/36. Here, too, the differences are statistically significant, but the V-P score differences do not reliably discriminate between normal and exceptional populations.

Corning, Steffy, and Chaprin (1982), in an ongoing brain-behavior assessment program, studied 59 children in a project researching the relationship between EEG data and behavior. The children were selected from a total group of 92, 19 of which were invited to participate because they were perceived as normal; the balance had been referred from a variety of agencies on the basis of a number of perceived difficulties: delinquency, hyperactivity, attentional problems, impulsiveness, learning and cognitive disorders, and other social and emotional problems. All participants had had WISC-Rs within two months of their EEG assessment. On the basis of EEG assessment, the children were divided into two groups, a diffuse slow frequency (DSF) group and a normal frequency (NF) group. Group inclusion was based on ranking on "each of three spectrally derived indicies: delta (.5-3.5 Hz), delta plus theta (.5-7.0) Hz), and the theta/alpha ratio" (p. 516). Highest and lowest rankings on several electrode sites determined group membership.

The DSF group were below normal on all Verbal subtests except Comprehension but scored in the normal range on all the Performance subtests except Coding. When the groups were compared on the basis of relative scores, the DSF group manifested significant weakness on both the Information ($p \leq .05$) and Block Design ($p \leq .01$) subtests compared to the NF group. The Verbal IQ for the DSF group was 92.6 (SD 14.6) as compared to 112.1 (SD 13.4) for the NF group. The Performance IQs compare, for the DSF and NF groups respectively, 101.3 (SD 17.5) to 113.8 (SD 12.4). The NF group exhibited little discrepancy between Verbal and Performance IQ (V>P = 1.7) while the DSF group's IQ scores differ by 8.7 points. Sixteen of the students referred on the basis of learning disability fell in to the DSF group; one LD child was classified as normal frequency. This result seems to demonstrate again that LD students tend to score higher on performance measures and lower on verbal measures than do normal students. The V-P difference manifest does not, however, distinguish the LD children from the hyperactive children, or children with an emotional disturbance.

There is evidence that an individual's WISC or WISC-R scores may be influenced by his or her membership in a cultural, ethnic, or racial group (Brody & Brody, 1976; Vernon, 1979). A case in point is an investigation by Teeter, Moore, and Petersen (1982). Teeter and her colleagues examined the WISC-R profiles of three groups of Navajo children. The 452 subjects in their sample, who ranged in age from 6-0 to 16-10, had all been referred for psychological assessment as a result of school related problems. The groups established were nonhandicapped (NH), educationally disadvantaged (ED), and learning disabled (LD). The authors note that in the LD sample only those children whose deficit was primarily visual-processing--as opposed to auditory-processing--were selected. The selection was made to insure the homogeneity of the sample. All three groups obtained PIQs approximately 30 points greater than their VIQs. In this study, the LD group showed the least differential between verbal and performance abilities, and that difference averaged 28.9 IQ points. The ED group showed the greatest difference with a discrepancy of 34.2 points while the NH sample scored an average of 30.3 points P>V difference.

Kaufman (1981) says "despite the factor-analytic construct validity support for Wechsler's Verbal-Performance dichotomy, there is . . . reason to doubt the practical value of the simple V-P IQ discrepancy for [diagnosing] LD or potentially LD children." He goes on to suggest that the Freedom from Distractibility factor "may hold the key to competent LD assessment" (p. 521).

LEARNING DISABILLITIES AND THE "ACID" PROFILE

Alan Kaufman asserts that research has consistently shown that "diverse groups" of the LD population score low on the Arithmetic, Coding, Information, and Digit Span subtests of the Wechsler Scales (1979: 1981). Smith (1978) reports a 1974 study by R.P. Rugel which found a unique profile was manifest overall in 25 investigations of WISC subscores and LD with the lowest mean scores in Arithmetic, Digit Span, and Coding; and highest scores in Object Assembly, Block Design, Picture Completion, and Picture Arrangement. He also reports that C.B. Huelsman concluded after a 1970 review of a "substantial body of literature" that there was a WISC profile for disabled readers which included low scores in "Arithmetic (100% of the studies reviewed), Coding (95%), Information (80%), and Digit Span (60%)" (p. 4). Block Design, Picture Completion, and Picture Arrangement were the subtests most consistently elevated. More recent investigations using the WISC-R have shown similar patterns.

The LD students in Bracken, Prasse, and Breen's 1983 investigation obtained low scores on the WISC-R in the following (ranked low to high): Digit Span, Arithmetic, Information and Vocabulary; Coding was the fifth lowest score. In the 1977 study by Smith, Coleman et al., the learning disabled children received their lowest scores on Information, Arithmetic, Coding, and Vocabulary. The Digit Span subtest was not given to the group of children assessed in this study.

Henry and Wittman investigated five groups of children;

two levels of LD (higher and lower), one of educable mentally handicapped, one emotionally disturbed, and a group of gifted children (1981). Each group was composed of 40 children drawn from grades 1 through 6. The profile of low scores obtained by the lower IQ LD group was Digit Span as the lowest score, Arithmetic and Coding tied as the next lowest scores, and Information was the fourth score. The profile for the higher IQ LD sample was Information, Digit Span, Arithmetic, and Coding. The EMH children exhibited a somewhat different pattern: Picture Arrangement, Information, and Arithmetic, with Digit Span and Block Design in a tie at the fourth position. The ED group's profile was the mirror image of that of the higher IQ group. They scored lowest on Coding, followed by Arithmetic, Digit Span, and Information.

A large study by Moore and Wielan (1981) of 434 children referred for reading difficulties yielded results similar to those reported above. Their "reading referred" sample ranked, low to high, Digit Span, Coding, Arithmetic, with Information and Vocabulary tied in the fourth lowest position. A group of 161 learning disabled students involved in a study by Smith (1978) to determine the stability of WISC-R profiles exhibited a pattern of scores that, for the most part, fits the ACID profile when it is considered that the Digit Span subtest was not administered. Their profile was Information, Arithmetic, Coding, and a

Vocabulary-Similarities tie.

Two of the studies previously reviewed which did not show significant V-P discrepancies, do show the ACID profile or an approximation thereof. Anderson, Kaufman, and Kaufman (1976) found the lowest scores for their 41 LD children on Similarities, Information-Vocabulary (tie), and Arithmetic. Coding appeared in the fifth position. Vance, Gaynor, and Coleman's (1976) learning disabled children's PIQ-VIQ score differential was less than one point; nonetheless, the ACID profile seems to emerge. Digit Span was not given, but the three remaining subtests in the profile, Arithmetic, Coding, and Information, formed the lowest triad.

There is an obvious relationship between the ACID profile and the Freedom from Distraction factor. The Freedom from Distraction factor (Arithmetic, Coding, and Digit Span) forms, as Kaufman (1981) points out, three-fourths of the ACID profile. As previously noted, Kaufman has suggested that it is the Third, or Freedom from Distraction, factor that may hold the key to LD assessment. There are, however, some difficulties with that position. There seems to be little more evidence that the ACID profile or the Freedom from Distraction factor will separate LD students out of other exceptional populations any more effectively than will examination of PIQ-VIQ differences.

Corning, Steffy, and Chaprin's diffuse slow frequency (DSF) group manifests a profile that is very close to the ACID profile: Digit Span, Information, Coding, and Vocabulary, with Arithmetic in a close fifth place (Vocabulary mean scaled score = 8.5; Arithmetic = 8.8). The DSF group does not, however, include only learning disabled students; it includes hyperactive, emotionally disturbed, delinquent, and other exceptional children. On the other hand, the normal frequency group in the same study--a group of 25 children of which 14 were invited to participate because they were preceived as normal and only one of which was referred on the basis of LD--exhibited an "equally ACID" profile: Coding, Digit Span, Mazes (often excluded in LD studies), Arithmetic, and Information. Henry and Wittman's (1981) gifted group, a group with a mean VIQ of 129.1 and a mean PIQ of 123.5, obtained their lowest score on the Freedom from Distraction factor in the following order: Coding, Digit Span, and Arithmetic.

The Navajo LD children studied by Teeter, Moore, and Petersen (1982) provide a profile quite different from those of the Caucasian and, it is assumed, black children in other LD studies. The American Indian children in the learning disabled sample obtained their lowest scores on Vocablary, Information, Comprehension, and Similarities. An educationally disadvantaged group of Navajo children showed the same profile, and a nonhandicapped group of Indian children manifested weakness on the same four tests, although the low-high pattern was different, i.e., Vocabulary remained as the low score, but Comprehension and Information exchanged places; Similarities retained its fourth place.

The results of Teeter and her colleagues' investigation should perhaps caution that there are subtle racial/cultural factors operating in performance on the Wechsler Scales that should be taken into account. It may well be, for example, that Anderson, Kaufman, and Kaufman's 1976 study was influenced by the racial/cultural mix of their sample-- more than half of which were non-white. That sample had significant representation from the Mongoloid race, and three of the four subtests which were low in the investigation of Navajo children were low in the Anderson-Kaufman sample. It seems likely that Moore and Wielan's 1981 study included significant numbers of black students, and if that were the case, it is possible, recalling studies reported by Vernon (1979), that the racial/cultural mix influenced the results obtained in ways that dilute the effect of learning disability on the profiles.

In summary, the Freedom from Distraction factor operates like V-P discrepancies in that it is often found in LD populations. And it suffers the same liability as V-P discrepancies: it does not reliably distinguish LD children from other exceptional groups, or, as has been shown, from normal or even gifted children. To compensate for the liability, it has been proposed that the other Wechsler subtests must fall into some pattern with regard to the subtests which form the Third factor if that factor is to have the desired diagnostic value. One proposal for a diagnostic pattern among the subtests is Bannatyne's recategorization.

BANNATYNE'S RECATEGORIZATION OF THE WECHSLER SCALES

In 1968 A. Bannatyne proposed, on the basis of his clinical experience with disabled readers, a recategorization of the Wechsler Scales. He suggested four categories, Spatial, Conceptual, Sequential, and Acquired Knowledge. The Spatial category includes Picture Completion, Block Design, and Object Assembly; it assesses spatial abilities including the abilities to manipulate objects and images in space, to form appropriate figure-ground relationships, and to experience gestalt closure at the appropriate time. (Kaufman, 1979, suggested that Mazes is a logical member of this category but was excluded, perhaps because it is frequently omitted in testing.) The Conceptual category essentially measures verbal conceptualization and is composed of Comprehension, Similarities, and Vocabulary. Originally, the Sequential category included Digit Span, Picture Arrangement, and Coding; however, by 1974 Arithmetic was substituted for Picture Arrangement making the category identical with the Freedom from Distractibility factor. The final category, Acquired Knowledge, measures a child's success with "school-like" tasks and is developed from the Information, Arithmetic and Vocabulary subtests.

Bannatyne's recategorization included the proposition that reading disabled children would exhibit a particular pattern or profile of categories. It was suggested that reading disabled children would have Spatial scores greater than Conceptual scores and Conceptual scores greater than their Sequential scores. Acquired Knowledge was not ranked in the sequence, but it usually ranks low, often comparable to the Sequential category.

It should be noted in fairness to Bannatyne that it was not his proposal that a child would be diagnosed on the basis of his or her Wechsler Scale scores alone. In his 1968 article, he proposed that all or many of the following instruments and procedures should be included in an assessment: a standardized achievement test, the ITPA, the Frostig, the Graham-Kendall Memory for Designs, an auditory discrimination test, the Road Map Test of Direction Senses, the Benton Right/Left Discrimination Test and the Harris Laterality Test. He suggested as well that personality, emotional, and motivational factors should be assessed and that, when it seemed germane on the basis of other observations, the child should be assessed at the neurophysiological level. Bannatyne suggested a "funneling-in" technique in which no further investigation of an area was required when a child demonstrated adequate to strong function but areas of weakness were examined in depth. These recommendations have not, however, claimed the same attention as has his recategorization of the WISC and, subsequently the application of his recategorization to the WISC-R.

Other investigators have tended to expand Bannatyne's application recategorization to include learning disabilities as a general category rather than limiting it to children with genetic dyslexia, the group for which Bannatyne originally proposed the recategorization. A study by Smith, Coleman, Dokecki, and Davis (1977) is a case in point. Smith and his co-researchers studied 208 "school-verified" LD children. The children ranged age from 6-3 to 12-1 and had a mean age of 9-9. All were drawn from LD classrooms in a large metropolitan school system. The school system's LD criteria according to Smith, Coleman, et al. were "(1) severe academic deficits, usually of two or more years and in one or more areas, (2) a Full Scale IQ score of at least 75 on previous testing, and (3) no severe problems in vision and/or hearing" (p. 50). The children's WISC-R scores were recategorized according to Bannatyne's scheme, with the exception of the Sequential category. Because Digit Span had not been included when the children were originally tested, the Sequential score was derived by averaging the Arithmetic and Coding scores. The children were divided into high and low IQ LD groups, and a subgroup of EMH children was developed from the low IQ LD group during the statistical analysis.

The authors report that the total sample and the high and low IQ groups conformed to the expected pattern of Spatial>Conceptual>Sequential; the EMH group of the low IQ LDs scored higher in the Sequential category than in the Conceptual. The differences between categories in all cases were significant at the $p<.001$ (or less) level. In examining the frequency of the Spatial>Conceptual>Sequential pattern, Smith and his colleagues ranked the scores of each child highest to lowest to determine the relative frequency with which each score was high, low, or intermediate. Seventy percent of the children scored highest in the Spatial category, 23 % highest in the Conceptual category, and 7% in the Sequential category. In the second rank, 21% of the children received their second highest score in the Spatial category, 48% in the Conceptual and 31% in the Sequential category. Spatial scores were lowest for 9% of the children, 29% received their lowest scores in the Conceptual category, and 62% scored lowest in the Sequential. The investigators observe that while the proportion of children expected to manifest the

Spatial>Conceptual>Sequential profile was 17%, 43% actually exhibited the pattern. On the basis of these results, they conclude that "school-verified LD children" are characterized by the same pattern of abilities that Bannatyne ". . . found for children with genetic dyslexia and that Rugel (1974) reported for disabled readers in general . . . thus, evidence that the LD child is characterized by a unique pattern of WISC and WISC-R subtest scaled scores continues to mount" (p. 442).

Other investigators have been more cautious in asserting the utility of Bannatyne's recategorization. Henry and Wittman (1981) considered the diagnostic implications of the recategorization in a study of 200 elementary school children. Forty children were selected at random from each of the following programs: LD in full-time placement, LD in part-time resource rooms, emotionally disturbed, educable mentally handicapped, and gifted. Their results conformed to the recategorization pattern for the LD, full-time; LD, part-time; EMH; and ED groups at significant levels ($p<.05$). The gifted group did not conform but revealed a Conceptual>Spatial>Sequential pattern. Acquired Knowledge ranked between Conceptual and Spatial for the gifted children. Further analysis indicated that 52.5% of the LD, full-time; 55% of the LD, part-time; 47.5% of the EMH; 65% of ED; and, 15% of the gifted children conformed to the recategorization hierarchy. When, however, the researchers required that there be two or more points between categories the percentages of students conforming to the hierarchy dropped dramatically: LD, full-time 5%; LD, part-time 5%; EMH 2.5%; ED 2.5%; and gifted 2.5%. On the basis of Bannatyne's classification, 37 of 80 children previously diagnosed as LD would have been classified as non-LD while 45 of 80 children previously diagnosed as non-LD would have been reclassified as LD. Bannatyne's recategorization incorporates the same diagnostic flaws as do V-P discrepancies and Freedom from Distractibility analyses: the recategorization does not cleanly delineate children with learning disabilities from other children. The point is further made in studies of delinquent children.

Groff and Hubble (1981) applied, in part, the research methodology used in the investigation of Smith et al. (1977) to a group of 193 male juvenile offenders. The age range of the sample was 9 to 16 years and the mean age was 15. Their results with high and low IQ groups were very similar to those obtained by Smith and his colleagues. Groff and Hubble comment: "The significant pairwise comparisons for the juvenile dellinquents in this study paralleled exactly the significant contrasts for LD youth reported by Smith et al. (1977)" (p. 516). They concluded that their results did not support the assertion that LD youth manifest a unique pattern of scores according to the Bannatyne hierarchy. Groff and Hubble did not, however, exactly replicate the testing data used by Smith et al. (1977). Digit Span was not included in the tests Smith and colleagues used in their investigation of LD children; Groff and Hubble's sample did not have Comprehension scores. It seems probable that the absence of Comprehension in the Conceptual category is more likely to bias the category score than is the absence of Digit Span in the Sequential category in as much as Comprehension is not infrequently among the highest scores of exceptional groups (Anderson et al. 1976; Corning et al. 1982; Henry & Wittman 1981; Moore & Wielan 1981; Vance et al. 1976). The converse is true of Digit Span. Digit Span, in the Sequential category--the low category for reading disabled children in Bannatyne's hierarchy--is frequently among the lowest scores obtained by exceptional children (Bracken et al. 1983; Corning et al. 1983; Henry & Wittman 1981; Moore & Wielan 1981). On its own this study engenders some reservations, but it need not stand alone. Its findings are supported in another source.

Miller, Burdg, and Carpenter (1980) conducted a study very similar again to that of Groff and Hubble. They analyzed the WISC-R results of 97 (65 males and 32 females) adjudicated juveniles, ages 11-0 to 16-3, with a mean age of 14-3. The group was an approximately even racial mixture. In this case, as with Smith and colleague's (1977) sample, Digit Span was not measured. All other subtests ordinarily included in the recategorization were available.

As with the Smith et al. and Groff and Hubble studies, the sample was divided into three groups: high IQ (FSIQ $\geq$ 90); low IQ (FSIQ $\geq 70 < 90$); and, a group of 25 whose FSIQs were below 70. Again, as with the previous two studies mentioned, significant ($p \leq .05$) differences were found between groups. In this case the Spatial>Conceptual>-Sequential did not hold for the highest IQ ($\geq$90) group. The high IQ group exhibited a Conceptual>Spatial>Sequential pattern. The two lower groups manifested the expected pattern. Miller et al. conclude that their investigation adds "adjudicated youths to the growing list of groups which support the recategorization of WISC-R scores suggested by Bannatyne" (p. 190). Their conclusion, stated in positive terms, seems, nonetheless, to yield further evidence that the Bannatyne recategorization does not differentiate LD youth from other exceptional groups.

Of perhaps greater concern than the failure of the Bannatyne recategorization to differentiate between LD and other children is the concern that the category ranking schema may mask more significant diagnostic differences. (It seems appropriate to note that in all probability the same risks inhere in classification on the basis of any of V-P differences, the Freedom from Distraction factor or the ACID profile.) The significance of the concern that important differences between children will be mask in overreliance of classification by category ranking is illustrated in the results of a study by Ryckman and Elrod (1983). They investigated the WISC-R results of two samples of LD children who had attended the District Learning Center (DLC) in Bellevue Washington. The first group of children, 91 boys and 26 girls with a mean age of 8 years, had attended during the 1974-1976 school years. The second group, 67 boys and 24 girls, had a mean age of 7-10 years and were enrolled in the 1978-1979 school year. The mean IQs of the two groups were 101.0 and 97.0, respectively. Ryckman and Elrod summed the WISC-R scores according to Bannatyne's recategorization schema and calculated standard deviations for each category. In each case the deviations were near six, and six or fewer points difference between categories was considered non-significant. [Six points represents the 99% level of confidence (Reynolds, 1981); Reynolds and Gutkin (1981) provide statistics for Bannatyne Recategorizations of WPPSI subtests.] A ten-point variation was considered extreme. They describe their groups and the criteria for membership:

> Group 0: Residual -- included all children not classified according to the criteria for the other groups.
>
> Group 1: No Difference -- required a variation of six or fewer points between all categories.
>
> Group 2: Genetic Dyslexia (Bannatyne 1971) -- required that Spatial be greater than Conceptual and

> that Sequential be 10 or more lower than Spatial.
>
> Group 3: Sequential Deficit -- required Conceptual be greater than Spatial but by less than 10 points and that Sequential be 10 or more lower than both Conceptual and Spatial.
>
> Group 4: Concept Strength -- required Conceptual to be 10 or more greater than both Spatial and Sequential (p. 87).

Both groups yielded nearly identical profiles which were Conceptual>Spatial>Sequential. Ryckman and Elrod describe their results as "reasonably consistent with data from prior studies" despite the Spatial-Conceptual turn-around. They point out that while there were small differences between Spatial and Conceptual, both were significantly greater than Sequential and that all the studies considered showed a significant Sequential deficit. More important, they observe that a total group profile would mask potentially important differences between subgroups of learning disabled children. Sample 1, for example, showed the following subgroupings: Residual 35.9%, No Difference 22.2%, Genetic Dyslexic 21.4%, Sequence Deficit 8.5, and Concept Strength 12.0. Sample 2 was very similar in masked differences: Residual 33%, No Difference 24.2%, Genetic Dyslexic 24.2, Sequence Deficit 4.4%, and Concept Strength 14.3. The differences masked may be important both in diagnosis and remediation.

There seems no convincing evidence that a Spatial>Conceptual>Sequential pattern based on Bannatyne's recategorization of the Wechsler Scales uniquely identifies learning disabled children, and as several studies point out, the chance of mis-identifying children on the basis of the Bannatyne recategorization is great. Mis-identification leads to mis-diagnosis and inefficient or inappropriate remediation. The outcomes of profile analysis based on Bannatyne's criteria are, for the most part, of no greater or lesser utility than those deriving from V-P differences or Third factor analysis. The inability of the approaches examined to make satisfactory diagnosis of learning disabilities has lead other researchers to look not at patterns of the subtests but at the range of scores learning disabled children obtain. It has been hypothesized that the variability of performance characteristic of many LD students will be reflected in their WISC, WISC-R or WPPSI subtest scores.

LEARNING DISABILITIES AND SUBTEST SCATTER

Dudley-Marling, Kaufman, and Tarver (1981) reviewed five studies undertaken between 1971 and 1979 investigating subtest variability and report that only one investigator found greater variability among LD groups than was found in normal groups, and that investigator concluded that high scatter alone was not of diagnostic value. Kaufman comments that "the small difference between LD and normal scatter that has been observed in previous investigations may, if fact, represent a selection bias stemming from the stereotype [that learning disabled children have subtest scatter and large V-P IQ differences]; i.e., other things being equal, children with apparent WISC-R scatter are more likely to be labeled LD than those with flatter profiles" (1981. p. 523). Investigations since those reported by Dudley-Marling et al. have produced similar conclusions.

David Ryckman computed the indexes of scatter on the WISC-R for 25 girls and 75 boys all of whom had been diagnosed as having severe learning disabilities. The mean age for the group at the time of testing was 7-10. The IQs reported were FSIQ 98.13 (SD 15.06), VIQ 97.96 (SD 11.09), and PIQ 98.90 (SD 11.96). Scatter indexes were calculated on the 10 regular WISC-R subtests. Three indexes of test scatter were used--the same three used by Kaufman in his 1976 study: (1) the size of the difference between the highest and lowest scaled score earned by a child, (2) the number of tests deviating from the child's own mean score by three or more points in either direction, and (3) percentage of children with three or more scale score points difference between any two subtest scores. Ryckman found (1) that the LD children presented significantly more variablity of range on all three IQ scores; (2) the LD group had significantly more tests which deviated from each child's personal mean when the means were calculated on the Full Scale scores and on the Verbal scores but not when calculated from the Performance scores; and (3) that the percentages of cases in the learning disabled sample which varied three or more points between any two tests ranged from 30% between Vocabulary and Comprehension to 65% between Comprehension and Coding. The mean percentage was 49. In comparison, the standardization sample ranged from 29% to 52% with a mean of 44%. This study, too, demonstrates significant differences but, again, with an overlap of normal values so great as to negate the diagnostic value of subtest scatter.

Moore and Wielan's investigation of subtest scatter among 434 elementary school students referred to the University of Georgia Reading Clinic revealed a similar pattern: significant differences between the "reading referred" group and the standardization sample were found on each of the indexes described in the previous studies. Because the samples in each case were so large, significant differences were found but the actual point score differences were very low. Moore and Wielan point out that only about 0.5% of the variability in V-P discrepancies can be accounted for in terms of group membership and that only about 0.4% of the variance in the Performance scale can be explained by group membership. They suggest that their findings provide "additional evidence to disconfirm the belief that substantial range on the Verbal, Performance, and Full Scales is characteristic of reading and learning disabled youngsters" (p. 514). This investigation conforms as well to the pattern established in previous paragraphs: significant statistical differences, but actual point score differences so small as to be of little or no diagnostic value.

On the basis of the research reviewed, there is no confirmation of the belief that LD children exhibit subtest scatter that has diagnositc utility if scatter alone is the criteria for labelling a child learning disabled. Scatter, especially low scores, should, however, be an important aspect of educational planning for both normal and LD children (Kaufman, 1979).

CHAPTER SUMMARY

Factor analytic studies have supported the division of the Wechsler Scales into a Verbal and Performance aspect, and a number of studies have investigated the relationship of LD to differential performance on the two scales. Those studies have, for the most part, found significant differences between the Verbal and Performance scores obtained by LD children and those obtained by normal children. While the differences found are statistically significant, they have no or little diagnostic utility. There is considerable overlap between the score differential obtained by learning disabled children and those obtained by normal children. Further, VIQ-PIQ or Verbal Comprehension factor-Perceptual Organization factor discrepancies which are significantly different from those of normal children are not unique to LD populations but are found among several exceptional groups, e.g., mentally retarded, juvenile delinquents, EEG diffuse slow frequency children, and Amerind populations.

The Freedom from Distraction factor and the ACID profile similarly show statistically significant differences between normal and LD groups, yet the ACID profile is found among other groups as well, even among gifted children; hence, low scores either on the Third factor or on the ACID profile are not diagnostic of an LD child. The implication of the findings discussed is that the differences between LD, normal, and other exceptional groups are more subtle than those which are reflected in the common variables underlying the three major factors of the Wechsler Scales.

Bannatyne's recategorization of the Wechsler scales although derived from clinical experience rather than factor analysis coincides rather closely with the factors identified through factor analysis--a coincidence that, again, perhaps validates the division of the scales. Bannatyne's Conceptual category is Verbal Comprehension less Information, Spatial is Perceptual Organization less Picture

Arrangement, and Sequential is identical to Freedom from Distractibility. His fourth category, Acquired knowledge, is drawn from Verbal Comprehension (Information and Vocabulary) and the Third factor (Arithmetic). Inasmuch as Arithmetic loads moderately (.37) on the Verbal Comprehension factor and the other two load substantially, it might be argued that Acquired Knowledge is simply another measure of Verbal Comprehension. In any case, Acquired Knowledge is not an essential category in the hierarchy of categories said to identify disabled readers/learners.

Perhaps because they so nearly reflect the factors obtained through factor analysis, analysis on the basis of Bannatyne's hierarchical recategorization yields results similar to those already discussed. LD children as a group do conform to the Spatial>Conceptual>Sequential hierarchy when no consideration is given to levels of confidence, but when investigators demand that there be at least two points difference between category means [fewer points than the 4.5 plus required for the 95% level of confidence (Reynolds, 1981)] the proportion of children conforming to the hierarchial profile drops from about fifty percent to five percent or less. The research results do not suggest that Bannatyne's recategorization has any greater utility than those previously reviewed.

Research studies examining the relationship between subtest scatter recapitulates the results already examined: significant differences in scatter exist between LD and normal groups, but with so much overlap between the two groups in terms of actual subtest scores that scatter alone has little value in classifying children as learning disabled. It appears that despite the impressions formed by many working in the field of learning disabilities the Wechsler Scales are, of themselves, of limited value in diagnosing learning disabilities. Not a single one of the often used approaches to diagnosis on the basis of Wechsler Scales--V-P differences, Third factor and/or ACID profile, or subtest scatter--is reliable for an individual child.

Regardless of the lack of success in finding a Wechsler profile indicative of learning disabilities through the means explored thus far, there is another approach to the examination of Wechsler subtest scores and their association with success or lack of success in school that requires examination. Kaufman (1979) has suggested that V-P discrepancies may be indicative of differences in cognitive style. He suggests that "it is possible that sizable V > P discrepancies on the WISC-R may be indicative of a more pervasive field-dependent cognitive style, with P > V differences signifying field independence" (p. 41). Other writers have suggested that a field independent cognitive style is more facilitative of school success than is a field dependent style (Cohen, 1969; Goodenough, 1976; Shade 1983; Witkin, Moore, Goodenough, & Cox, 1977). Chapter Three examines field dependence, and its relationship to the Wechsler Scales.

CHAPTER 3

REVIEW OF THE LITERATURE -- COGNITIVE STYLE

Witkin, Moore, Goodenough, and Cox (1977) outline the essential characteristics of cognitive styles in general (pp. 15-16). Cognitive styles, they assert, are (1) concerned with the form rather than the content of cognitive activity, that is, "how people perceive, think, solve problems, relate to others, etc."; (2) pervasive across all areas of human intellectual activities; and (3) bipolar, each pole having adaptive value in certain circumstances. Cognitive styles are important in accounting for individual differences. The particular cognitive style with which Witkin et al. are concerned is field dependence.

In the course of research during the late 1940's and early 1950's on how people orient themselves in space, it became apparent that some individuals were more vulnerable to mis-perceive their orientation in space when they were presented with a visual stimulus that provided information conflicting with that provided by their other senses. Persons exhibiting susceptibility to disoriention by the visual stimuli were described as field dependent, i.e., dependent on the visual field as they attempted to orient themselves in space. Further research by Witkin and his colleagues demonstrated that the tendency to be dominated by the most salient stumulus in a field was a pervasive attribute and not limited to spatial perception. They began to catalogue the characteristics of both field dependent and field independent individuals. The differences they discovered between persons as each pole conformed to the criteria established for designating a complex of behaviors as a cognitive style. The differences in perceptual processing were shown to be pervasive elements in an individual's whole style of processing information and not limited exclusively to visual-perceptual behaviors. The field dependent pole was designated as the global style and the field independent pole as the articulated style. Both sets of terms, field dependent/independent and global/articulated, appear in the literature.

Field dependence-field independence is measured by requiring the subject to break a complex stimulus into its parts and to attend differentially to either the various parts or to other stimuli in the stimulus complex that compete with a salient visual stimulus. The Rod and Frame Test (RFT) consists of an luminous square frame that can be rotated right or left about its centre with a luminous rod that can be rotated about the same centre. Both the frame and rod may be tilted away from the vertical, and the subject's task, in a darkened room, is to bring the rod to the exact vertical. A field independent subject will be able to position the rod within a few degrees of a true vertical position despite a tilted frame which creates a competing visual stimulus. A field dependent person will be influenced by the tilted frame and, using the frame as a reference point, will be unable to orient the rod vertically in a number of trials. In some laboratories the chair in which the subject sits, as well as the rod and frame, may be tilted creating additional competing stimuli.

A second measure of field dependence is the Body Adjustment Test (BAT). In this test, the body is the object of perception. The subject's task is to orient his body in a true vertical position while seated in a chair that may be tilted clockwise or counterclockwise. The competing visual stimulus in this test is a small room into which the chair is projected. The room may also be tilted about the same axis as the chair and may be tilted independently of the chair. A third measure of field dependence uses similar equipment. In the Room Adjustment Test (RAT), the subject is required to orient the room to the vertical while seated in a tilted chair.

The fourth means of determining an individual's position on the field dependence-independence continuum is the Embedded Figures Test (EFT). The challenge is to apprehend and trace with a stylus a simple geometric figure such as a cube, cross, or triangle in a more complex figure. Field independent persons are able to discover the simple figures embedded in the more complex stimulus more quickly than field dependent persons. Several variations of the EFT are available such as a Group Embedded Figures Test (GEFT) and a Children's Embedded Figures Test (CEFT). The Gottschaldt Hidden Figures Test is an other measure of field dependence. Like the EFT, it requires the subject to discover a target figure in a more complex stimulus matrix. Witkin et al. (1977) observe that "the common denominator underlying individual differences in performance in these various tasks is the extent to which the person perceives a part of a field as discrete from the surrounding field as a whole, rather than embedded in the field; or the extent to which the organization of the prevailing field determines perception of its components; or to put it in everyday terminology, the extent to which the person perceives analytically" (pp. 6-7).

CHARACTERISTICS OF FIELD DEPENDENT AND FIELD INDEPENDENT COGNITIVE STYLES

Field independent or articulated individuals are less dominated by the salient visual stimulus of the field and are able to analyze the field for its various parts and to restructure the field if such restructuring is more appropriate to the task at hand. Field independent individuals tend to be active learners and use mediation to restructure information presented to the senses. They are able to attend selectively to the stimulus field and focus on details of the field most relevant to their need at the time. Articulated individuals are task oriented. Their approach is impersonal, and they tend to be interested in the abstract and theoretical. Field independent individuals are not attentive to social stimuli unless that stimuli is relevant to their task. They show "greater autonomous achievement striving" (Witkin & Goodenough, 1977, p. 667), and they operate from internal frames of reference. The self is experienced as one's own; one's needs, feelings, and attributes are distinct from other's feelings and attributes, and field independent individuals have greater sense of self and nonself than do field dependent persons. Their body concept is articulated; the body has definite limits and the parts are discrete but interrelated. Finally, field independent persons tend to use specialized psychological defenses such as intellectualization.

In contrast field dependent individuals invest little in restructuring a stimulus field and tend to accept the overall field as it is given. They tend to be more passive learners than do field independent persons. Their orientation is interpersonal. Field dependents are attentive to social cues. They, for example, look more at the faces of others than do field independent people; they attend more to verbal messages if those messages have social content (Eagle, Goldberger, & Breitman, 1969); and they are drawn to people and like to be physically close to them.

Persons with a global cognitive style attend to and make use of the prevailing social frames of reference, and their orientation is toward external social referents. They tend to blurr and adhere less closely to internal frames of reference. They experience greater continuity between self and nonself. Their social roles tend not to be defined as distinct from the roles of those with whom they interact. In like manner, their body concept is less articulated and more generalized. The psychological defense mechanisms used by field dependent people tend to be nonspecific, e.g., repression.

The field independent individual or the individual with an articulated cognitive style is said to exhibit greater "psychological differentiation" (Witkin, Dyk, Faterson, Goodenough, & Karp, 1974), that is, his or her intellectual functioning is more specialized according to the nature of the situation or problem making demands on him or her; hence, the response he or she makes can be more differentiated and more appropriate to the specific demand. Some investigators have suggested that the basis of psychological differentiation, and as a result, field dependence or independence, lies in the sensitivity of the nervous system, or in psychophysiological differences.

Di Vesta and Bartoli (1982) found that field independent subjects were better able to detect both auditory and viaual signals while they were imaging than were field dependent subjects, yet the two groups did not differ in the accuracy of detection of isolated signals. Fine (1973), working wih 56 males, found that field independent soldiers could discriminate subtle variance in both color and weight more accurately than field dependent soldiers. In Fine's study field dependence-independence was determined with the use of Gottschalt Hidden Figures. He also reports a 1972 study by Blasi, Cross, and Herbert in which 20 field dependent and 20 field independent subjects were selected through the use of the Rod and Frame Test (RFT). Visual cues were controlled and the subjects were asked to estimate a comparison weight within the context of two different original weights. The field independent subjects were less influenced by the context, and the differences between the field dependent and field independent groups was significant at the $p<.01$ level. At least two investigators offer evidence that field dependent and field independent individuals differ psychophysiologically. A.J. Silverman (1982) reports differences between groups at the two poles of field dependence in superficial vein constriction when blood is drawn, in response to insulin-induced hypoglycemia, in resting blood pressures, and a number of other vascular responses. David Robinson (1982) reported significant differences ($p<0.005$) between field dependent and field independent subjects in electrical cortical activity as recorded by an EEG.

Witkin and his colleagues (Goodenough, 1976; Witkin et al., 1974; Witkin et al., 1977; Witkin & Goodenough, 1977) offer considerable evidence that psychological differentiation as expressed in field dependent and field independent styles is a suffusive characteristic of an individual's life. An individual's cognitive style is expressed not just in those activities considered primarily cognitive, e.g., problem solving, or perception but in all aspects of life, social, educational, and vocational. If the evidence of Fine, Robinson, and Silverman is accepted, psychological differentiation should perhaps be labelled 'psychophysiological differentiation', suggesting an even more pervasive aspect of an individual's functioning. The concern of this research is, however, with the relationship of field dependent and field independent cognitive styles, ability, and achievement.

FIELD DEPENDENCE AND THE WECHSLER SCALES

There is a body of research describing the relationship between the 'spatial tests'--Picture Completion, Block Design, and Object Assembly--of the WISC, WISC-R, and WAIS and field dependence. Field independence correlates with high scores on Picture Completion (PC), Block Design (BD), and Object Assembly (OA). Witkin, Faterson, Goodenough, and Birnbaum (1966) identify the triad of subtests with "tests of perceptual field dependence" and note that the common requirement of all the tests is "the ability to experience items as discrete from the organized field of which they are a part--in other words analytical ability" (p. 302). Analytical ability is an aspect of the articulated (vs. global) cognitive style and is, according to Witkin and his colleagues, indicative of a high level of cognitive differentiation.

Goodenough and Karp (1961) in a factor analytic study note that the three tests, PC, BD, and, OA are variously identified as a Non-verbal Organization factor, a Spatial-perceptual factor, a Performance factor, a Visualization factor, a Perceptual Speed factor, and a Closure factor. They chose to use the last term, and observed that the tests which define the Closure factor all demand the capacity to overcome embeddedness for successful performance. Their investigation with two groups of children (Group A: 25 boys and 25 girls, age range 11.5 - 12.5 years; Group B: 30 boys, age range 9.5 - 10.5) found that three tests of perceptual field dependence, RFT, EFT, and BAT, have their heaviest loadings on the same factor as do the CEFT and Hidden Pictures, and that the three WISC subtests in the Closure factor were also heavily loaded on the same factor. They observe that their results "tend to support the Witkin hypothesis that relationships obtained in many studies between tests of field dependence and standard tests of intelligence stem, at least in part, from common requirements shared by measures of field dependence and of certain kinds of intellectual abilities" (p. 245).

Elliot (1961) re-examined some of the relationships to which Goodenough and Karp allude. He reports, on the basis of then recent studies, that the EFT tends to be correlated to any measure of ability, and that it shares about 30% of its common variance with quantitative-spatial tests and about 10% with verbal tests. He notes that the RFT, in contrast, tends to have a slight negative correlation with measures of ability. Elliot suggests that the EFT and RFT have approximately 15% variance in common--a considerable drop, he notes, from the 55% first reported by Witkin. (It should be noted that subsequent studies have tended to find results more comparable to Witkin's than to Elliot's.) He hypothesizes that the differences between the correlation of the EFT and the RFT with measures of ability lie in the nature of the task. The EFT, Elliot suggests, contains items that are very similar to those used on some aptitude tests and, like those aptitude tests, it is timed; hence, it yields clues for arousal of concern over evaluation, and it activates achievement-motivation. In contrast, the RFT has few such cues: it is not timed and it does not overlap achievement test items. Elliot concludes that the RFT and other measures of verticality are purer measures of field dependence because they are less "multifactorial."

More recently, Swyter and Michael (1982) studied 160 gifted and superior children. The group studied was equally composed of Anglos, Asians, blacks, and Hispanics and of males and females. The children ranged in age between 7-8 and 9-3 years. Correlations were drawn among four dependent variables: Children's Embedded Figures Test Scores, WISC-R Composite (PC, BD, and OA), Concept Assessment Kit--Conservation (CAK-C), and Machover Draw-A-Person Test (MDAP). Two patterns of factor loadings emerged from factor analysis. One factor exhibited "substantial" loadings on the CEFT and on the three WISC-R subtests. The intercorrelation of the CEFT and WISC-R Composite for the total group was 0.58 and the range was from 0.38 (blacks) to 0.69 (Anglos). The second factor manifest high loadings on the CEFT, the CAK-C measure, and the Block Design subtest. Swyter and Michael suggest that their findings are consistent with the field dependence-field independence construct.

D. Robinson (1982), working with data derived from EEG analysis and other measures including the WAIS and EFT, also found an association between field dependence-independence and EFT performance. Robinson worked with a group of subjects who were, for the most part, in their mid-twenties. Fifteen of the 25 females and 23 males were either graduate or post-graduate students, and, as a group, their Verbal IQs exceeded their Performance IQs by 10 to 14 points. In addition to the usual factors found in the Wechsler scales, his analysis yielded a factor which had heaviest loadings on the Lie score of the Eysenck Personality Questionnaire (EPQ) (-0.63), Picture Arrangement subtest (0.54, Block Design subtest (0.52), EFT (0.52), and the Psychoticism score of the EPQ (0.47). Object Assembly had the lightest loading (0.02) of all the WAIS subtests in this factor. In the Perceptual Organization factor, however, Object Assembly again emerged strongly. The loadings reported are Field Independence (EFT) 0.66, Block Design 0.66, and Object Assembly 0.64. Picture Completion at 0.39 loaded somewhat lighter than Picture Arrangement (0.42) and Similarities (0.42) from the Verbal Scale.

The association of higher scores on the Wechsler subtests identified as measuring spatial perception, the PC, BD, and OA triad, presents a paradox. A number of exceptional groups including learning disabled, mentally retarded, autistic, delinquent, and emotionally disturbed children tend to achieve their highest scores on the spatial triad of the Wechsler scales (Anderson et al., 1976; Bracken et al., 1983; Henry & Wittman, 1981; Shah & Frith, 1983; Teeter et al., 1982; Witkin et al. 1966). The implication that would seem to follow is that these children should be relatively field independent, that their cognitive style should be relatively articulated, and that they should be psychologically differentiated. Yet, the studies to be examined next provide evidence that psychologically differentiated and field independent individuals demonstrate superior achievement when compared with field dependent persons, and the groups listed above are not superior achievers.

FIELD DEPENDENCE, LEARNING, AND ACHIEVEMENT

The body of research suggests that there is no significant difference in the "sheer learning ability" of field dependent and field independent persons (Coward & Lange, 1979; Goodenough, 1976; Long, 1962; Witkin et al. 1977). There are, however, differences in how and what field dependent and field independent individuals learn, how they perform on some intelligence tests, and the levels at which they achieve in some circumstances.

Rosalie Cohen (1969) suggested that North American schools demanded a particular cognitive style or strategy. Students who are analytical rather than global processors; stimulus- or object-centered, rather than self-centered; and able to abstract and categorize information using non-obvious features have a substantial advantage in school or school-like situations. Cohen identified the cognitive style of such students as analytical: those who process globally were described as having a relational style. It seems apparent that analytical style can be identified with Witkin's field independence and the relational style with field dependence. Cohen believed the cognitive styles she observed were primarily a product of a child's socialization. B. Shade (1983) designed a study to test the achievement aspect of Cohen's hypothesis.

Shade studied a group of 135 grade nine students randomly selected from groups stratified by sex, race and achievement level. The sample included 59 Afro-American students and 76 European-Americans; 60 of the group were male and 75 were female. Achievement level was determined from standardized achievement tests given in the school district. Students who scored in the top three stanines (7, 8, 9) were classified as high achievers; those who scored between the fourth and sixth stanines were considered average achievers; and, those who scored in the lowest three stanines were labelled low achievers. The following instruments were used to assess the students: Group Embedded Figures Test, Visual Attention Task, Clayton Jackson Object Storting Task, Picture Classification Task, the Gestalt Completion Task, and Myer-Briggs Type Indicator [of cognitive style].

Analysis of variance showed significant differences between the three groups on all but the Object Sorting Task, and that task was dropped from further analysis. Regression analysis suggested that the same factor or factors were encompassed by the GEFT, Visual Attention, Picture

Classification, and Gestalt Completion tasks. Using only the GEFT and Myers-Briggs Type indicator, Shade did a discriminant analysis. In that analysis, the average achievement group clustered about the mean and the high and low achievement groups fell at opposite ends of the scale. Her results revealed that differences in achievement could be correctly identified at least 74% of the time using only the GEFT and Myer-Briggs Type Indicator. She observed that high achievers were predominately field independent--or, in Cohen's terms, analytical processors; the low achievers were predominately field dependent.

In general, Shade's work confirms the characteristics of field independent and field dependent children already discussed. The field independent students in her study were able to structure tasks, able to direct themselves, able to deal with abstract and theoretical material (and interested in such material), and able to handle visual material. They took a hypothesis-testing approach to learning. They were also self-motivated, capable and desirous of working alone, rational/logical processors, and task-oriented. The field dependent or relational processors needed cues from their environment to solve problems; had difficulty providing their own structure; liked working with people, and did well when doing so; and were skilled in remembering material--especially material from a social context. They had no difficulty learning, Shade says, but they preferred to learn in an auditory or kinesthetic manner. The low achievers tended to be perceptual/sensory processors as opposed to rational/logical processors (p. 491).

Kagan and Zahn (1975) in a study with Mexican-American children also found field dependence to be a factor in achievement, and following Cohen (1969), they too observed that American schools favor a field independent cognitive style. They suggest that their findings bear on the nature of field dependence in four ways. First, they suggest that their results support the well established finding that children from more restrictive families and cultural groups tend to be more field dependent. Second, their findings are consistent with an interpretation of field dependence as a function of cognitive development rather than school learning. They observe that age is a better predictor of field dependence than is grade. Third, the assertion that field independence is related to quantitative and spatial ability and unrelated to verbal ability is not supported. And fourth, they suggest that traditional measures of field dependence may predict achievement because variables other than the ability to separate figures from an embedding context are assessed. They suggest, for example, that the traditional measures of field dependence may assess such variables as the ability to perceive true verticality, the need to be careful, or the motivation to be very precise.

Other investigators have observed the association between verbal ability and field independence that Kagan and Zahn noted. Berent and Silverman observed such a relationship in a 1973 study. The intent of their study was to examine the relationship between field dependence and lateralized cerebral functioning. They hypothesized that field dependent subjects would manifest impaired performance on visuo-perceptive learning tasks but not on verbal learning tasks. The subjects were 50 female undergraduates. The women were first administered the verbal and visuo-perceptive paired-associate learning tasks, and then field dependence was determined with the RFT. The 10 lowest and 10 highest scores were then assigned as extreme field independent and extreme field dependent respectively. No significant differences were found between the two groups on the visuo-perceptive paired-associate task, and the field independent subjects performed equally well on both tasks. The field dependent students, however, showed impairment on the verbal paired-associate task. Performance differences on the two tasks for the field dependent students were significant at the $\underline{p}<.02$ level.

In a 1974 study Berent found that field dependent female patients of the inpatient Psychiatric service of the University of Virginia Medical Center performed less well on a writing task than did field independent patients. The patients were divided into three groups on the basis of scores obtained on the Rod and

Frame Test. The lowest and highest 20% were assigned as field independent and field dependent, respectively. The middle 20% were described as "field-middle." The mean ages for the groups, approximately 30 years, did not differ significantly. All groups had essentially the same level of education, and all patients had been diagnosed as either neurotic or having adjustment reaction at the time of their discharge. The writing task was to copy a 75-word passage from a standard intelligence test. The writing samples were evaluated by three independent judges using a semantic differential scale of 1 (poor) to 5 (good) on the basis of legibility, orientation on the page, neatness, and over-all writing quality. The field dependent subjects spent longer times writing but produced less legible and less well oriented samples than did either the field independent or field-middle group. The overall quality of writing from the field dependent women was also judged inferior to that of the other two groups. All differences were significant at the $\underline{p}<.01$ level.

Long (1962) studied the rate of verbal learning among 52 adult females (mean age 30.4). His sample was drawn from housewives, secretaries, and business college students. The sample was divided on the basis of scores on Thurstone's Concealed Figures Test (CFT) into two groups of high field-articulated and low field-articulated. The 52 women included represented the 25% with the highest and the 25%

with the lowest scores on the CFT from an original sample of 125 subjects. The women were required to learn two ten-word lists of similar meaningful words. The high field-articulated group learned the word list significantly ($p<.01$) more quickly than did the low field-articulated group.

Long (1962) also investigated the efficacy of a "warm up" or practice period for the high and low field-articulated groups. The rate of original learning was not different for two groups of high field-articulated subjects, one of which had received the warm up exercise and one of which had not. On the other hand, a group of low field articulates receiving the practice session learned the word lists in significantly ($p<.05$) fewer trials than did their counterparts who did not have the practice. This result seems to show, again, the importance of external structuring for field dependent groups.

In the same study, Long investigated recall with interference, i.e., retroactive inhibition and proactive inhibition. When his subjects had learned List A to one correct trial they were required to learn List B. Ten minutes after learning List B to one correct trial the subjects were required to write the words learned in their correct order. (During the ten minute delay the women participated in an unrelated size-estimation task.) Only words written on the right list and in the right order were scored as correct. Under the constraint of having to have the words in the right order and on the right list, the high field-articulated group had significantly ($p < .01$) higher scores than did the low field-articulation group. Despite this difference, Long points out that it is important to notice that both groups, the high and low field-articulates both recalled about the same total number of words; the high field-articulates recalled a total of 457 words while their low field-articulate counterparts recalled a total of 450. The difference between the two groups was manifest in their ability to place the words on the correct list and in the right order. Long concludes that "the field-articulation control principle is an important determinant of learning and recall in an interference situation" (p. 157).

Berger and Goldberger (1979) investigated the relationship between field dependence and short-term memory in a complex set of procedures. Berger and Goldberger investigated the relationship between field dependence and short-term memory when each of an interference and a registration factor was involved. Interference implies interference in the consolidation of a memory trace, while registration is concerned with the measure of strength of registration of the stimulus trace. The interference factor was evaluated through more difficult tasks such as a retroactive inhibition task and long lists of digits. The registration factor was investigated with short lists of digits and proactive inhibition tasks. The investigators predicted that independent subjects would perform better than field dependent subjects on the interference factor tests and that there would be no significant difference on the registration factor tests.

Berger and Goldberger's subjects were college students, 41 males and 33 females, with a mean age of 19.38 years. Field dependence was determined by using both the RFT and the EFT (a short form). The interference factor was considered to be measured by Long Digit Span (15 digits of which the subject was to recall 12), a Retroactive Inhibition task, and Delayed Digit Span (4 to 7 digits). Registration was evaluated with Immediate Digit Span (4 to 7 digits), a Proactive Inhibition task, Delayed Digit Span (4 to 7 digits), and Immediate Digit Span (2 to 9 digits). The participants were also given a vocabulary test composed of 20 of the 40 vocabulary words from the WAIS as a measure of general intelligence, and each was given an attention test composed of 30 statements from the Columbia Attention Test, as well as a testing experience questionnaire.

Berger and Goldberger report that all the interference factor tests correlated significantly ($p<.001$) with both the EFT and the RFT, while only the Delayed Digit Span (4 to 7 digits) test of the registration factor correlated significantly ($p<.001$). The field independent subjects exhibited superior performance on the interference-laden short term memory tasks. Their superior performance was attributed to their greater ability to selectively focus attention on the appropriate stimulus. The field independent subjects were shown to be more involved in the EFT and the RFT as well as the memory tasks. Their greater involvement was attributed to either their greater task-orientation or to their preference for socially neutral stimuli, or both factors.

In 1979 Coward and Lange investigated the relationship between recall and recall-organization behaviors with field dependence in children in grades one and four. Field dependence-independence was determined through the Children's Embedded Figures Test, and 20 subjects (out of 30 possible) were selected at each grade level on the basis of the 10 highest and 10 lowest scores. Following field dependence testing, a standard viewing-recall test was administered to the children. The test required the children to name, then study 20 colored pictures representing four taxonomic categories (animals, foods, people in occupations, and vehicles) for 60 seconds; perform a 30-second counting backward buffer task when the pictures were removed; and, then, recall from memory as many of the picture names as possible. Sixty seconds was allowed for free recall. A second trial was administered in the same manner as the first except the naming was omitted. A sort-recall test was then administered following a three-minute inter-task conversation. The sort-recall test introduced 20 new colored pictures of familiar objects which in this case were not obviously taxonomically or otherwise related to each other. The children were instructed to try to arrange the pictures into groups of their own choosing with the limitation that the number of groups should not exceed six. The children were encouraged to group the pictures physically into their categories. They were allowed as much time as they required to sort the pictures. When the sorting was complete, the 30-second buffer task was administered and the 60-second recall task was begun.

Coward and Lange had anticipated that the field independent children would manifest better recall and greater organization on both the experimental tasks. They found, rather, no significant differences in the amount of recall or in the apparent organization of recall between the field dependent and field independent children on the standard viewing-recall task. The field independent children did, however, excell in both organization and recall on the sort-recall task. Coward and Lange suggest that their findings "appear to reflect greater abilities among field-independent children to establish homogeneous, distinct and stable stimulus groupings when permitted to use self-derived classificatory criteria, and perhaps, greater tendencies to refer to these groupings at the time of recall" (p. 196).

In commenting on individual differences in field dependence, free recall, and recognition, Goodenough (1976) reports that the supposition that field independent individuals would show more effective ways to organize information in general for recall has been supported by only a few studies. The majority of studies, he says, have not found field independent subjects to be superior to field dependent subjects in free recall. When, however, the demands of the task are more structured, especially when sequencing is required or categorization other than the obvious or familiar is demanded, as has been shown in the studies presented here, field independent subjects do tend to excell when compared to field dependent subjects. It would appear that ambiquity is a catalyst which piques an individual's cognitive style.

Differences between field dependent and field independent individuals tend to express themselves in the presence of an ambigious situation. Coward and Lange's (1979) field dependent and field independent children performed equally well on an unambiguious standard viewing-recall task; differences manifest themselves when the structure of the material to be learned became more ambigious. Long's (1962) field dependent and field independent women learned and recalled the same number of words, but the field dependent women learned them faster when a learning model--a structure--was first imposed, and the field dependent women had greater difficulty preserving the structure of the word lists. Elliot (1961) describes the response to ambiguity as follows:

> Field dependence is the tendency to react with affective and intellectual disruption when the subject's situation is masked by unusualness, incongruity, confusion, or lack of structure in general. (All these terms are descriptive of the RFT situation.) Such disruption lasts until some system or order is imposed upon the situation either by the subject or some external agency. A field dependent subject is relatively unable to impose such structure autonomously: hence if an order is introduced he accepts it, and we can observe dependent behavior; if an order is not introduced, he remains disrupted (a condition that could best be observed, perhaps, with psychophysical measures) (p. 35).

One group of investigators have raised the possibility that the inability to impose order or to extract a figure from its context as measured by the GEFT specifically, and other measures of field dependence by implication, is an indication of cognitive impairment rather than cognitive style (O'Leary, Calsyn, & Fauria,1980). However, the observation that as many field dependent persons as field independent persons successfully complete all levels of education, participate in many professional fields, plus the observation that cognitive styles have little correlation with college grade point average (Witkin et al., 1977), make their hypothesis relatively unattractive; such behavior does not equate with what is ordinarily understood as 'impaired'.

A more attractive and more extensively researched hypothesis is that field dependence is a function of cerebral differentiation/lateralization.

FIELD DEPENDENCE AND CEREBRAL DIFFERENTIATION/LATERALIZATION

A number of studies have investigated aspects of the relationship between field dependence and cerebral differentiation or lateralization (Berent, 1974; Berent & Silverman, 1973; Bloom-Feshbach, 1980; Cohen, Berent, & Silverman, 1973; O'Connor & Shaw, 1978; Zoccolotti & Oltman, 1978). Inasmuch as some of the consistent differences shown between normal and LD children [e.g., VIQ-PIQ discrepancies, higher scores on spatial tasks relative to their verbal scores manifest by many LD youngsters, and lower scores on the Freedom from Distraction factor (Kaufman, 1979)] may, at least in part, reflect differential function of the cerebral hemispheres, such studies seem relevant to this investigation. Table 3-1 drawn from Brumbach and Staton (1982, p. 1091) and Garrick (1978, p. 632) summarizes laterality of cerebral hemispheric function.

The table indicates something less than total unanimity in the location of all cerebral functions. Garrick, for example, locates vigilance in the left or dominant hemisphere while Brumback and Staton locate arousal, attentiveness, and activation--functions which would seem

TABLE 3-1

LATERALITY OF FUNCTION IN THE CEREBRAL HEMISPHERES

Left (or Dominant)* Hemisphere	Right (or Nondominant) Hemisphere
Cognitive Function Language skills Expression and comprehension of written and spoken language Analysis over time (Garrick) Notes conceptual similarity to the exclusion of visual (Garrick) Perceives detail (Garrick) Codes in terms of linguistics (Garrick) Lacks a Gestalt synthesizer (Garrick)	Cognitive Function Spatial perception orientation and integration spatial visualization synthesis over space (Garrick) Notes visual similarity to the exclusion of conceptual (Garrick) Perceives form (Garrick) Codes in terms of images (Garrick) Lacks a phonological analyzer (Garrick) Creative thinking (Garrick) Left-right discrimination Ordering and sequencing Timing and time perception Appreciating pitch and tonality of sound (Music appreciation)
Sensorimotor Function Sensation of the right body Movement of the right body Perception of the right visual field Appreciation of sound from the right ear Complex motor function (Garrick)	Sensorimotor Function Sensation of the left body Movement of the left body Perception of the left visual field Appreciation of sound from the left ear
Emotional Function	Emotional Function Prosody Empathy and comprehension of emotionality Affective behavior
Attentional Functions Vigilance (Garrick)	Attentional Functions Arousal Attentiveness Activation

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[*] Garrick uses the terms 'dominant' and 'nondominant' to locate hemispheric function. In right handed individuals (dextrals) the left hemisphere is usually designated as the dominant hemisphere; in sinistrals the dominant hemisphere is often the right.

to equate with vigilance--in the right hemisphere. While Brumback and Staton do not distinguish complex motor behavior from other motor functions, Garrick adds it to the left hemisphere. Other functions unique to Garrick's categorization are indicated with her name in parenthesis following the function. In many cases the disparities reflect a difference in approach to an aspect of cerebral function or in the elaboration of a function rather than a solid disagreement; others reflect real differences of opinion. Total unanimity is also lacking in the hypotheses concerning the relationship of field dependence and cerebral lateralization.

Cohen, Berent, and Silverman (1973) found changes in field dependency in response to electroconvulsive shock treatment (ECT) delivered unilaterally to either the right or left hemisphere. The subjects were 36 women who were admitted to the Carrier Clinic, Belle Mead, NJ. The subjects were depressed but free of neurological disease and no signs of alcoholism were exhibited. Twelve subjects received left-hemisphere ECT, 12 received ECT to the right hemisphere, and 12 controls did not receive ECT between two administrations of the RFT. Rod and Frame Tests were administered to all ECT patients before and after their treatment. As a result of left-ECT patients became more field dependent while right-ECT patients became more field independent. Analysis of variance showed significant groups (right, left, and no ECT) by test (RFT) interaction (p<.001).

The authors note that these results conflict with earlier research in which they found that right hemisphere ECT impaired performance on a spatial forms test, implying increased field dependence. They suggest that a more detailed examination of the two tasks can resolve the apparent paradox. They point out that the forms task requires the testee to inspect a series of designs in order that one part of the design can be later reproduced in relation to another part. The task requires the subject to distribute his or her attention over all parts of the design; the Rod and Frame Test, on the other hand, allows the subject to achieve accuracy by attending only to the rod, the most salient element of the stimulus configuration. The explanation offered for the differential results is that right hemisphere ECT may attenuate the patient's responsiveness to the stimulus field allowing some of its less salient elements to fall below an attentional threshold. The less salient element in the RFT test would be the frame. Cohen et al. reason that their findings for the right and left cerbral hemispheres can be integrated by relating them, respectively, to scanning and field articulation, two cognitive controls of attention deployment. They observe that "the scanning control which is thought to determine the extensiveness with which an individual samples data from a stimulus field would appear to be mediated by structures of the right hemisphere," and "in contrast, the field articulation control--the meaningful sorting-out of elements of the field relative to a given task--would seem to be mediated by structures of the left hemisphere" (p. 167).

Berent and Silverman (1973) found further evidence of left hemisphere influence in field dependence in a previously discussed study involving female undergraduates. Ten highly field independent and 10 highly field dependent subjects on the basis of RFT scores were drawn from a sample of 50 women. The groups exhibited no significant differences on visuo-perceptive paired-associates tasks. On the verbal tasks (verbal paired-associates), however, the field dependent women showed impairment relative to their field independent peers. Berent and Silverman interpreted this finding as further evidence of left or dominant hemisphere involvement in field dependence. A subsequent study by Berent (1974), also previously reported, in which the writing performance of field independent female psychiatric inpatients was found to be superior to that of field dependent patients was taken as additional evidence that left-cerebral-hemisphere function is a major influence in field dependence, i.e., that impairment of some functions of the left hemisphere, namely, field articulation control, results in increasing field dependency.

Garrick (1978) advances an alternative hypothesis. She points out that there are a number of similarities between the characteristics of field independent individuals and the characteristic mode of right hemisphere function, and the similarities of the left hemisphere's characteristic mode of functioning and the characteristics of field dependency. Garrick notes that field independent individuals are superior in performance on the perceptual aspects of IQ, flexibility of closure, spatial tests, perceptual concept formation, and creativity. All of these, she asserts, are right hemisphere functions. She asserts, further, that when imagery is involved, verbal paired-associates tasks and verbal concept identification become right-brain functions, and field independent individuals are superior on these tasks as well. According to Garrick, in tasks that require complementary functioning of both hemispheres, the field independent person has an advantage because he or she has the ability to both perceive and conceptualize; the field dependent person is disadvantaged by inferior perceptual functioning.

The hypothesis that the right cerebral hemisphere is the locus of field independence is supported by the research of Bloom-Feshback (1980). Bloom-Feshback states that "the confounding problem [in the right hemisphere-left hemisphere debate] is the failure to recognize the dual nature of right-hemisphere superiorities" which are that the "nondominant hemisphere is specialized for differentiated cognitive processing, as in spatial-task performance" (p. 137). Differentiation, as he uses it, implies "greater capacity to articulate and act upon the complex interrelations among component parts." Spatial tasks require both a global visualization/imagistic capacity and a cognitive capacity which is visually analytic as opposed to analytic in linguistic concepts. He says that the right hemisphere is also specialized for less differentiated information processing. In this latter function he includes processing faces, the nonlinguistic speech components, and emotion. Alloting the right hemisphere dual specialization allows the correspondence between that hemisphere and such field independence functions as spatial ability, distance from emotion, and intentional face perception to emerge. The conceptualization also allows for the correspondence between the less differentiated right-hemisphere functions and field dependence, e.g., nonverbal communication, proximity to emotion, and incidental face perception. In developing this conceptualization of right-hemisphere functioning, Bloom-Feshback draws attention to a facet of differentiation which he believes has not been sufficiently focussed. He focuses integration. He points out that increasing differentiation is accompanied by hierarchic integration which presumes an overlap and interrelation of fundamental functions. With this background he suggests that "one may predict that the field-independent person will be superior at more differentiated right-hemisphere tasks and will also be better able to utilize the right hemisphere on characteristically left-hemisphere tasks" (p. 138).

Bloom-Feshback predicted the following: field independent subjects would perform better on spatial tasks than field dependent subjects; field dependent subjects would make fewer correct right-hemisphere (left-ear) responses on a dichotic listening task than would field independent subjects; and the two groups would show no significant differences on left-hemisphere (right ear) dichotic listening. His subjects were undergraduates, 25 female and 25 male. Field dependence was determined with the Portable Rod and Frame Test (PRFT). A standard dichotic listening task was employed in which the stimuli consisted of six consonant-vowel syllables (ba, da, ga, pa, ta, ka) presented in pairs. The spatial test required subjects to compare a two-dimensional geometric form with various three-dimensional forms. Results confirmed the hypothesis advanced. Spatial ability and the dichotic listening measure accounted for 30% of the field-dependence variance. Field independent students obtained higher left-ear (right hemisphere) scores on the linguistic dichotic task. That difference was taken to indicate increased differentiation and a higher degree of integration of fundamental cerebral functions.

Zoccolotti and Oltman (1978) investigated hemispheric specialization of verbal and configurational processing and field dependence. These investigators observe that while several studies prior to their own had linked field independence and lateralization, those studies had all employed verbal material and, as a result, are directly relevant only to left-hemisphere specialization for verbal function. They suggested that a comprehensive test of the differentiation model of field dependence would require that the extent of hemispheric specialization for both verbal and configurational material within one group of subjects be examined. In brief, their subjects, eighteen right-handed males between the ages of 18 and 30, were required to discriminate between four faces --two "go" and two "no-go", and four letters (A, F, E, R) on the same "go" or "no-go" basis. The upper-case letters served as the "verbal" material. The stimuli were presented tachistoscopically centrally and to the right- or left-visual hemifields. Field dependence was determined by both the RFT and EFT.

The results obtained by Zoccolotti and Oltman supported their hypothesis: relatively field independent subjects showed greater opposite lateral superiorities for both verbal and configurational material than did the field dependent subjects. They conclude that "the field-dependence-independence dimension is related to the degree of segregation of functioning between the two hemispheres, rather than some generalized tendency to use one or the other" (p. 161).

While these findings seem to support the role of hemispheric differentiation in field dependence, it seems possible to question the nature of the verbal stimuli. The upper-case 'A' readily decomposes to /, -, and \ (/-\), and the upper-case F to I, ¯, and -. It is doubtful that the letters require linguistic or verbal processing in the context in which they are presented, and it seems highly probable that they are processed as geometric forms. A similar criticism may be made of Bloom-Feshback's (1980) consonant-vowel combinations. The stimuli, while auditory, are not verbal in a linguistic sense; they have no encoded meaning and may be processed in the right hemisphere in a manner not dissimilar to the processing of music or rhythm. Bloom-Feshback's assumption that the phonemes ba, da, and so on were processed as linguistic material in the right hemisphere should only be accepted with some reservation, as should the assumption by Zoccolotti and Oltman that the upper-case letters A, F, E, and R were processed in the linguistic left hemisphere.

EEG data was used to explore the field dependence-laterality relationship in a 1978 study by O'Connor and Shaw. The purpose of the study was to examine the model relating psychological differentiation as measured by the

RFT and cortical differentiation on the basis of EEG coherence. Electrical activity of the same frequency is postulated to be indicative of synchronization of neuronal activity over an area of the cortex: the absence of synchrony, or coherence, between different subsets of neurons is held to indicate specialized activity or differentiation. Their subjects were paid student volunteers, 17 females and 7 males; 12 were right-handed and 12 were left-handed. The mean age was 22.3 years. Readings were taken in the eyes shut rest condition from the parietal (P3,P4) and occipital (O1, O2) lobes provide the EEG data. Field dependence was assessed with rod and frame apparatus.

The results obtained confirmed an association between field dependence as a measure of psychological differentiation and EEG coherence as a measure of neuronal differentiation. Lateral preference (handedness) was also associated as a measure of functional differentiation. High dextrality and low sinistrality were associated with field independence, while low dextrality was associated with field dependence. Dextral subjects ranked low on interhemisphere and intrahemisphere coherence suggesting cortical differentiation. Sinstral subjects presented a different picture. O'Connor and Shaw expected that strong sinstral subjects would be more field dependent and that they would show higher intrahemisphere coherence than those less functionally lateralized. Their prediction was upheld for left intrahemisphere coherence, but for the right hemisphere, they found that subjects ranking high on coherence tended to be field independent and relatively low on sinistrality; their pattern of concordance was similar to that of the right-handed group.

The studies of field-dependence presented reveal a number of similarities between field-dependent persons and some learning disabled children. The shared characteristics include difficulties in maintaining selective attention, a person- or social- rather than task-orientation, an inability to recall sequential and structural relationships in material learned, an inability or reduced ability to impose order in an unstructured field, difficulties with verbal (as opposed to configurational) material, and a tendency to be dominated by the most salient aspects of a situation. Another body of research develops a relationship between cerebral lateralization and learning disabilities. (Examples include Brumback & Staton, 1982; Hynd & Obrzut, 1981; McKeever & Huling, 1970; Rourke & Telegdy, 1971; Witelson, 1976; Witelson, 1977) The research reviewed in this section establishes the relationship between field dependence or psychological differentiation and cerebral lateralization or differentiation. Together these studies build a compelling case for the inclusion of tests of field dependence in the psychoeducational assessment of learning disabilities.

CHAPTER SUMMARY

The research reviewed in this chapter shows field dependence-independence to be a pervasive personal attribute that manifests itself in an individual's personality, social life, and cognitive functioning. A number of studies in fact suggest that there are significant psychophysiological differences between field dependent and field independent persons. Field dependence, as it is measured through the commonly used tests, primarily the Rod-and-Frame Test and the Embedded Figures Test, reflects an individual's ability to perceive part of a field as discrete from the whole field, or, put another way, to discern appropriate figure-ground relationships with regard to the demands of a given task. A field independent person has such abilities: he or she thinks and perceives analytically and is said to be psychologically differentiated. The field dependent person, in contrast, is dominated by the field as a whole and has a lesser ability to separate figure from ground or to restructure figure-ground relationships in accordance with the demands of the task; he or she perceives globally and is said to be less psychologically differentiated.

Field independent students tend to be high achievers and are able to score more highly on some intelligence tests. A few investigators have argued that the field independent student's greater success in school achievement reflects the demands of the North American school systems. Others focus on the advantages that accrue from an analytical style of information processing. The ability to attend selectively, to be precise, to impose structure where there is no apparent structure, and to preserve the structure of material learned offer the field independent student a number of advantages. Personality characteristics such as self-motivation and task-orientation offer additional advantages to students with the analytical cognitive style.

Other studies establish a positive relationship between field dependence and the spatial triad (Picture Completion, Block Design, and Object Assembly) of the Wechsler scales. This relationship when coupled with the observation that a number of poor achievement groups, e.g., learning disabled, mentally retarded, emotionally disturbed, most Amerind, and delinquent children, typically do better on the spatial subtests than they do on the other subtests suggests a paradox: high scores on the Wechsler PC, BD, and OA subtests are associated with field independence, and field independence is associated with strong achievement, yet the groups which tend to show their highest scores on the spatial subtests are low achievers. Part of the purpose of this investigation is to initiate a resolution of the apparent paradox.

Another puzzle is the source of field dependence. A number of researchers have suggested that field dependence or psychological differentiation is a function of cortical differentiation. Three competing hypotheses are offered: (1) field independence is a a function of specialization in the left cerebral hemisphere; (2) field independence is a function of specialization or lateralization of function in the right hemisphere; and, (3) field independence is a function of increased differentiation of function in both hemispheres. Inasmuch as there is some disagreement among investigators as to which cognitive functions are specialized to which hemisphere, and that some of the functions about which there is some disagreement are very likely involved in field dependence (sequencing of time vs. space; perception of form vs. detail; vigilance vs. arousal, attentiveness, and activation; and, scanning vs. field articulation), the third hypothesis seems the most tenable.

While the research undertaken in this thesis project is not specifically designed to test any of the hypotheses presented above, it may offer some tentative hypotheses with regard to the relationships that pertain among learning disabilities, field dependence and lateralization of function. An examination of the research questions and the methodology employed follows.

CHAPTER 4

RESEARCH QUESTIONS AND HYPOTHESES

This study addresses two main and two subsidiary research questions. The main questions are (1) Are there unique Wechsler profiles which will identify homogeneous subgroups of LD children? and (2) Does field dependence play a role in learning disabilities and the Wechsler profiles children will exhibit? The subsidary questions are (1) Is there an association between field dependence and subsets of WISC-R scores, i.e., between field dependence and the ACID profile, or between field dependence and Kaufman's Freedom from Distraction? and (2) Can an interaction between CAT score (achievement) strength or weakness, WISC-R scores (ability), and field dependence (cognitive style) be demonstrated.

WECHSLER PROFILES

Observations made by clinicians in the course of psychoeducational assessment suggest that LD children exhibit WISC-R profiles that differ from those of efficient learners. A large body of research accumulated during the last 30 years indicates that there are statistically significant differences between learning disabled children as a group and normal children as a group; however, the same studies show that the actual point-score differences between individual learning disabled children and individual normal children are so small, and that there is so much overlap between the score ranges of learning disabled and normal children that an examination of Wechsler profiles alone is not a sufficient basis from which to diagnose a learning disability. There is, then, a descrepancy between clinical experience and correlational studies with regard to the utility of Wechsler profiles for diagnosing learning disabilities.

Certain assumptions and methodological approaches have perhaps contributed to the discrepant outcomes of clinical experience and statistical studies. For example, many of the statistical studies exploring the relationship between Wechsler profiles and learning disabilities have begun with the assumption that learning disabled children form one homogeneous group. A number of researchers (Kaufman, 1979, 1981; Ryckman, 1981; Ryckman & Elrod, 1983) have begun to question that assumption. They have suggested rather that the learning disabled are a heterogeneous group composed of homogeneous subgroups. Investigators are just beginning to look for those homogeneous subgroups.

Another research problem arises in the precise definition of who is learning disabled. The definitional problem leads to a methodological problem of sample selection. Different investigators work from assumptions that differ with regard to the IQ score which ought to define the lower range of learning disabilities. In one sense it is accurate to define mentally retarded children as learning disabled. In a similar sense it would be accurate to suggest that hearing and visually impaired children are learning disabled. "Learning disabled", as it is usually defined in the context of research with the Wechsler Scales, refers to children without physical impairments and/or obvious emotional impairment, but with "average or better" intelligence or ability. A difficulty seems to arise in the tendency to associate 'average' with 'normal'. One can argue with some cogency that the Borderline and Dull (Low Average) classifications are normal. It is somewhat more difficult to argue that they are average or that those classifications should be included with "average or better", yet a substantial number of studies over the years have included those groups in their investigations of the associations between learning disabilities and Wechsler profiles (Smith, Coleman,Dokecki, & Davis, 1977).

The approach taken in this thesis research will avoid both the problems identified in the foregoing paragraphs. The children who participated in the research have all been tested with the WISC-R, in most cases because they have manifest some learning difficulty in their school careers. They are not, however, specifically identified as learning disabled. This investigation does not assume that all the children who have IQs in the average range and who exhibit difficulties in learning certain things are learning disabled, and that they form a homogeneous group. The approach taken here is, rather, to group the children by strengths and weakness in certain content and skill areas and to seek WISC-R profiles in relation to those subject and skill areas; it is to seek homogeneous subgroups within the larger heterogeneous sample.

The question of whether a child's learning disability is a matter of low ability has been managed by controlling IQ scores so that at least one of either the Verbal Scale or the Performance Scale IQ scores is equal to or greater than 90. The narrower definition of a learning disabled child as one whose failure to achieve is not primarily of some physical deficit, e.g., sight, hearing, or motor control, and as one who has "average or better" ability is accepted in this research project. This definition will avoid the objections raised, legitimately, by Smith et al. and others. The mean IQ scores for the children tested will fall very near the mid-point of the Average classification.

HYPOTHESIS I

The hypothesis advanced is that when WISC-R profiles are analyzed on the basis of strength or weakness in content/skill areas, significant differences between groups will be manifest. It is hypothesized that the following profiles will emerge: (1) strength in processing language, (2) weakness in processing language, (3) strength in math processing, (4) weakness in math processing, and (5) weakness in language and math processing. The differences between strength and weakness on the profiles may, on further analysis, be a factor of facility in sequential or simultaneous processing, recall-recognition differences, and/or field dependence-independence.

FIELD DEPENDENCE

A number of studies have shown an association between field independence and high spatial scores, i.e., the PC, BD, and OA subtests, of the WISC-R. Other studies have shown that LD children and other problem learners tend to score relatively higher on the same spatial tests than they do on the other subtests. Yet, a third series of studies shows a strong relationship between field independence and strong achievement. The research problem which presents itself is the need to describe the nature of the relationship between field dependence, achievement, WISC-R profiles, and adolescents who manifest learning difficulties. This thesis will investigate the association of field dependence with achievement and ability, and, incidentally, the interaction of field dependence, ability, and achievement.

HYPOTHESIS II

The following hypothesis is advanced.. Field independent students will show superior ability in areas assessed by the WISC-R and superior achievement in all content/skill areas measured by the CAT. Specifically, it is hypothesized that field independent students will show higher Full Scale, Verbal, and Performance IQ scores and, comcommitantly, higher scores on the Verbal and Performance Scales of the WISC-R. The following outcomes are also expected: (1) males will be slightly, but significantly more field independent than females; (2) the greatest differences between the field independent and field dependent groups will be manifest on the Performance scores; (3) males, being more field independent, will score slightly but significantly higher than females on the WISC-R subtests which are strongly correlated with field independence; and (4) the field independent group will achieve scores on the CAT subtests which are significantly higher than those scored by the field dependent group; and (5) that the differences will be greatest on the Language Expression, Math Concepts and Application, and Reference Skill subtests.

HYPOTHESIS II A

It is hypothesized that the following subsets of WISC-R subtests will be positively correlated with field independence: the spatial triad--Picture Completion, Block Design, and Object Assembly; an "analysis dyad" composed of Similarities and Block Design; and the Third Factor. It is further suggested that field independence will be negatively correlated with the ACID profile and with a profile that seemed to present itself in a pilot study for this thesis, VIDA. VIDA substitutes Vocabulary for Coding with Information, Arithmetic, and Digit Span. Finally, the field independent group should exhibit greater discrepancies in Verbal and Performance IQs, with the Performance IQ being the higher score.

HYPOTHESIS II B

It seems logical to assert that interactions will be found in which WISC-R subtest scores will vary differentially with combinations of strength or weakness in some content/skill area of the CAT and field dependence or independence. In view of the predictions made in the previous paragraphs, field independence should, for example, be a factor in CAT subtests requiring restructuring for solution, and the scores on the WISC-R subtests which are associated with field independence should be involved so that an interaction is demonstrated. It is difficult to suggest the range of possible interactions so this sub-hypothesis remains necessarily vague.

LATERAL DIFFERENTIATION --AN AFTERTHOUGHT

The research presented suggests an association between lateral differentiation and field independence. Although there seems to be general agreement that such a relationship exists, there is no unanimity as to the exact nature of the relationship. Some writers have suggested that field independence is associated with right-hemisphere functions, others suggest left-hemsiphere functions, while others have suggested increasing field independence results from increasing differentiation in both hemispheres. Some research has identified certain of the Wechsler tests with hemispheric function. It has been suggested for example that Picture Completion and Object Assembly are right-hemisphere functions (Kaufman, 1979). The higher scores that learning disabled children receive on those subtests may be indicative of some right-hemisphere influence in learning disability of one sort if the hypothesis that there are several homogeneous subgroups of LD types is correct. Language functions are typically associated with the left hemisphere as is sequential ability. High scores on the Language Expression subtest of the Canadian Achievement Test should suggest strong left-hemisphere function. The coincidence of high scores on Language Expression and high field independence scores would support the hypothesis that field independence is at least in part a left-hemisphere function. If field independence is associated with differentiation and integration in both hemispheres, higher achievement and ability scores showing little variation or scatter may be indicative of hemispheric differentiation and integration.

The finding by Witelson that males demonstrate strong lateralization in hemispheric function by the time they enter public school, and that females may be relatively undifferentiated at least until the onset of puberty has implications for information processing and field dependence in males and females (1976). Results obtained by Riding and Boardman (1983) which showed that field independence resulted in better performance on all aspects of map reading for boys (14-year olds) but made no difference for girls is a case in point. Witelson has also observed an association between bi-hemispheric representation of spatial function and developmental dyslexia. She suggests that the bilateral processing may interfere with the left hemisphere's linguistic processing. Her hypothesis fits well with observations made of some groups of learning disbled children, i.e., strong spatial skills--presumably resulting from bi-lateral processing--hand weak language skills. While this thesis is not designed to explore lateralization of function and its role in WISC-R profiles obtained, the research indicated above, as well as that of several other investigators, may have some explanatory value when considering results. With that possibiity in mind, the methodology to be used has been designed so that the role of sex differences in information processing or differential lateralization will not be masked.

CHAPTER SUMMARY

This thesis examines the hypothesis that learning disabled children form a number of homogeneous subgroups and that those subgroups will exhibit a characteristic WISC-R profile when categorization is based on differential achievement in content/skill areas. It is further hypothesized that the profiles obtained will be associated with psychological differentiation, i.e., field dependence-independence. The relationship of field dependence to hemispheric lateralization of cognitive function is briefly reviewed.

CHAPTER 5

METHODOLOGY

SAMPLE

The research group is comprised of 216 boys and girls between the ages of 17.16 and 13.33 years with a mean age of 14.83 years. The children selected to participate had all written the Canadian Achievement Test (Levels 15 - 18) in either the 1983-1984 or the 1984-1985 school year when they were in grade seven or eight, and all had been tested with the WISC-R within three years of the date on which they wrote the CAT. The children had been referred for WISC-R testing on the basis of some perceived learning difficulty. One hundred thirty-four boys and 83 girls are included in the research sample. Of these, 118 boys and 70 girls also wrote the Group Embedded Figures Test as a measure of field dependence in late May and early June 1985.

The study also includes a small comparison group. The children in the comparison group were given WISC-Rs as a result of having been referred to the Challenge program. Because most this group was tested at the grade five level, the limit of three years between the administration of the WISC-R and the CAT was not observed. (The mean age difference between the age at which the students in the

Comparison group wrote WISC-R and the CAT was 2 years 9 months as compared with about 7 months for students in the research group.) These students wrote the CAT and GEFT at the same time as the research group. The age range for the comparison group was from 15.33 to 13.08 years. Table 5-1 shows the ages at which the various groups wrote the tests involved.

TABLE 5-1

MEAN AGES (AND SD) AT WRITING WISC-R, CAT, AND GEFT

	WISC-R	CAT	GEFT
Research Group			
Males	13.29 (1.03)	13.76 (0.73)	14.90 (0.79)
Range	16.00 - 10.25	15.33 - 12.25	17.16 - 13.33
N =	134	134	118
Females	12.98 (1.28)	13.71 (0.87)	14.81 (0.79)
Range	15.75 - 9.58	15.42 - 12.25	16.75 - 13.33
N =	82	82	70
Comparison Group			
Males	10.38 (0.68)	13.13 (0.68)	14.21 (0.65)
Range	11.50 - 9.00	14.25 - 12.00	15.33 - 13.08
N =	14	14	14
Females	10.45 (1.33)	13.19 (0.57)	14.22 (0.54)
Range	14.83 - 8.25	14.08 - 12.42	15.08 - 13.50
N =	17	17	17

Male in the research group wrote the CAT approximately five months, on the average, after they wrote the WISC-R and the GEFT aproximately a year and seven months later. The females wrote the CAT slightly more than seven months after their WISC-Rs and the GEFT a year and ten months after the

WISC-R. The mean time elapsed between the administration of the CAT and WISC-R to both males and females in the comparison group was two years nine months. The time elapsed between the WISC-R administrations and the GEFT testing was three years ten months for males and two years nine months for females. For the research group both the CAT and the GEFT were administered, on the average, within two years of the administration of the WISC-R and should be considered valid indicators of cognitive ability. The temporal distance between the administration of the WISC-R and the other instruments is greater in the comparison group, and perhaps the relationships that hold between the tests are not as valid as are those within research group. It is assumed, however, that the WISC-R scores are reliable enough to reflect any substantial differences between problem learners and high achievers and are, therefore, useful for the purpose they serve.

INSTRUMENTS

The Canadian Achievement Test

The Canadian Achievement Test (1983) is the Canadian version of the California Achievement Test. The California Achievement Test is, according to Salvia and Ysseldyke (1981), "adequately standardized, and the evidence for [its] reliability and validity is very good" (p. 143). The developers of the Canadian test have sought to achieve the same high standards.

The standardization sample for the Canadian Achievement Test consisted of approximately 76,000 students from grades one through twelve. The Technical Manual reports that stratified random sampling procedures were used to draw the students from national public and separate school populations. Schools were stratified on the basis of geographic reqion and degree of urbanization. Care was taken to adequately represent minority group populations and different SES levels. More than a thousand new Canadian items were written for the tests, and the generally higher achievement levels of Canadian students were considered in establishing norms.

Like its precurser, the CAT measures achievement K through 12 with eight levels (Levels 12 - 19). The students participating in this study wrote Levels 15 - 18, with most students writing Levels 17 and 18. Each of these levels includes eight subtests: Reading Vocabulary, Reading Comprehension, Spelling, Language Mechanics, Language Expression, Mathematics Computation, Mathematics Concepts and Applications, and Reference Skills. As well as reporting scores for each of the subtests, the CAT reports Total Reading, Total Language, Total Math, and Total Battery scores. Results are reported as raw scores, standard scores, grade equivalents, national percentiles, national stanines, local percentiles, and local stanines. This investigation uses standard scores for CAT data. Descriptions of the subtests derived from the CAT Class Management Guide (pp. 10 - 30) follow.

Reading Vocabulary: Five general areas are measured by this subtest. The student is asked to identify words with the same meaning, with opposite meanings, with multiple meanings. There are also items that measure the student's ability to deal with compounded word meaning and affixed word meaning. For vocabulary items testing opposite and same meanings, the stimulus word or definition is placed in a phrase or short sentence. The test developers suggest that doing so helps create a "mental image" for the student and that it helps clarify the word (CAT Class Management Guide 1983). The multimeaning words are presented such that the student must rely on the context to determine the correct meaning. All vocabulary items have three or four answer choices.

Reading Comprehension: The Reading Comprehension subtest measures literal, interpretive, and critical comprehension. Literal comprehension is described as "recall of facts", i.e., what is actually stated in the passage. Interpretive comprehension items "require students to identify the main idea, draw conclusions, recognize cause and effect, analyze characters, interpret figurative language, and use contextual clues to determine meaning" (p. 12). The figurative language techniques tested are sensory imagery, simile, metaphor, hyperbole, onomatopoeia, irony, and personification. The critical comprehension items demand that the student analyze and make judgements about the passages. The student is asked about an author's attitude or position and is expected to distinguish between fact and opinion, to recognize a point of view, to compare viewpoints, and to compare sources or various merit.

Spelling: The Class Management Guide explains that the spelling tests "are organized around the phoneme-grapheme-morpheme approach" (p. 15). Spelling problems associated with each of the following areas are tested: Consonants--variant sounds, silent letters, and digraphs; Vowels--short sounds, long sounds, and variant sounds; and Morphemic units--inflectional endings, suffixes, prefixes, similar morphemic units, and compound words. All spelling words are at or below the grade level for which the particular test is intended, and the words are presented in sentences. Two or three, depending on test level, stimulus words, each of which may or may not be misspelled, are underlined in each sentence and the student must identify the misspellings.

Language Mechanics: Language Mechanics assesses a student's skills in capitalization and punctuation. The capitalization items measure the student's knowledge of the basic rules of capitalization, namely, the pronoun I, proper nouns, proper adjectives, beginning words, and titles. The punctuation items of the subtest at Levels 14 - 16 assess the student's ability to use end marks (periods, question marks, and exclamation points), commas, and quotation marks. Levels 17 - 18 add colons and semicolons. The items are presented in single sentences and require only one response per sentence.

Language Expression: This subtest includes a variety of items which assess a child's knowledge of word use and his understanding of sentence structure and paragraph organization. Usage items include items which reflect the student's knowledge of irregular nouns and verbs, pronouns, verbs--especially agreement and tense, and adjectives. Sentence structure is concerned with proper syntax and includes items measuring knowledge of subjects and verbs; modifying and transitional words or phrases; and complete, incomplete, and faulty sentences at Levels 14 - 16. Levels 17 - 18 add verbosity and repetition, and misplaced modifiers and nonparallel structures. Paragraph organization is measured by requiring the student to determine the best sentence sequence in a paragraph, to eliminate irrelevant sentences, to determine the most suitable topic sentence, and the best concluding sentence.

Mathematics Computation: The computation subtest samples mathematical skills appropriate to each grade level. Various levels of the test measure addition, subtraction, multiplication and division of whole numbers, fractions, decimals, integers, exponents, and algebraic expressions. The problems are presented in horizontal and vertical arrangements. The distractors reflect frequent common errors which result from failure to rename, regroup properly, align columns, or reduce to the lowest common denominator; performing the wrong operation or a partial operation; misplacing decimal points; and selection of a distractor that visually resembles the stem.

Mathematics Concepts and Applications: The emphasis in the Mathematics Concepts and Applications subtest in on the student's ability to apply his or her understanding of the concepts of mathematics appropriately. Levels 15 - 18 measure the student's knowledge of numeration, number theory, number properties and number sentences, measurement, graphs, geometry, functions and graphs (Level 18), rounding and estimating, and problem solving.

Reference Skills: This subtest assesses a student's ability to use his or her reading skills to develop information from a variety of sources, e.g., tables, graphs, diagrams, dictionaries, library catalogue cards, and a periodical index. Beginning at Level 14, a student's ability to obtain and use information in a table of contents and an index page is examined. Levels 14 - 19 require students to demonstrate familarity with the dictionary usage. Items deal with guide words, definitions, homographs, syllabication, accent marks, pronunciation symbols, alternative pronunciations, parts of speech, restrictive labels, parts of speech, irregular plurals, and word origin. Map skills require the testee to relate symbols in the key to the map, interpret map labels and shading, make distance comparisons, identify locations by referring to cardinal and intermediate directions, and distinguish between specified routes. Student are asked to use two kinds of tables, one set listing characteristics of various subjects and another set describing schedules. The diagrams deal with stages in a cycle, the parts and characteristics of parts in a cross section, and historical time lines. The card catalogue items require a student to know the characteristics, uses, and kind of library catalogue cards. Success on items dealing with the periodical index is dependent on the student's ability to understand the order and meaning of the entries in the Canadian Periodical Index.

The Canadian Achievement Test assesses a wide range of student skills in several subject or content areas. It is anticipated that the test will be sensitive enough to differences in specific cognitive abilities to reflect those ability differences in the subtest scores. It is probable that subtests which require specific skills, the ability to restructure information for example, will be more sensitive to individual differences than will other tests which are dependent on more generalized abilities such as recognition. Reading Comprehension, Language Expression, and Mathematics Concepts and Applications would seem to demand more differentiated cognitive responses and are likely to be more sensitive to individual differences. The more sensitive subtests should show greater positive and negative correlations with WISC-R and GEFT scores.

Wechsler Intelligence Scale for Children--Revised

The 1974 revision of the WISC was the culmination of three years work during which time psychologists were consulted for critical comment, new items were written, and the test was standardized on a stratified sample of 2200 boys and girls between the ages of 6 1/2 and 16 1/2 years. In the preface to the WISC-R manual, Wechsler notes that the WISC had established itself as a "useful clinical and diagnostic tool . . . in the areas of educational assessment and the appraisal of learning and other disabilities" (1974, p. iii) and that the revisions sought to perserve and enhance those characteristics. There is little doubt that the revisions accomplished what was sought, and the WISC-R has become the most frequently used individual measure of intellectual ability in the field of psychoeducational assessment.

The WISC-R has high reliabilties on its major scales. The Full Scale average reliability coefficient is 0.96, the Verbal Scale 0.94, and the Performance Scale 0.90 All average standard errors of measurement for the major scales are less than five points (Sattler, 1982). The validity of the WISC-R has been established through a number of studies comparing the revision to other ability and achievement measures. Sattler describes the validity as "good" (p. 165). These qualities support the use of the WISC-R as a major tool in intellectual assessment.

It is anticipated that most of those reading this thesis will be well acquainted with the Wechsler intelligence tests; hence, this review of the tests will be brief and will focus on the subtests and what they are thought to measure rather than the history of the tests, details of administration, questions of reliability and validity, or such other matters. Those latter concerns are well covered in the WISC-R Manual (Wechsler, 1974). The focus on the subtests is appropriate in that it is in a child's success or lack of success on the various subtests that clues to the nature of his or her learning difficulties are thought to lie.

The WISC and WISC-R are comprised of two scales, Verbal and Performance and report three IQ scores, a Performance IQ Score, a Verbal IQ Score and a Full Scale IQ Score. Each scale has six subtests, five of which are added to obtain the IQ score for that scale. The Verbal subtests are Information (I), Similarities (S), Arithmetic (A), Comprehension (C), and, an optional subtest, Digit Span (Ds). The Verbal IQ Score is calculated by adding the scaled scores of the first five of these and converting to IQ on the basis of ages tables in manual. The Performance subtests are Picture Completion (PC), Picture Arrangement (PA), Block Design (BD), Coding (Cd) A or B (depending on age level), and Mazes (Mz) an optional subtest. The Performance IQ, as is the Verbal IQ, is based on the summed scaled scores of the first five subtests. The Full Scale IQ is calculated from the scaled scores obtained on the five Verbal and five Performance subtests. Both the WISC and WISC-R (as do the WAIS and WPPSI) report deviation IQs rather than IQs derived from calculation of mental age.

Success on the Verbal Scale is, according to Sattler (1982), based in verbal ability and includes the ability to process verbal information, to think with words, and to apply verbal skills and information encoded in words to problem solution. Success on the Performance subtests relies on the ability to comprehend the world visually, to think with and manipulate images and "to form relatively abstract concepts and relationships without the use of words" (p. 598). Sattler lists the following as required abilities for success on the Full Scale score: general intelligence, scholastic aptitude, academic aptitude, and the readiness to master a school curriculum (p. 597). Interestingly, the last three of these seem to include what Wechsler called "nonintellective factors", factors or traits such as persistence, drives attitudes, impulse control, and sensitivity to values (1974, p. 6). These may be described as elements of cognitive style and suggest the importance of cognitive style to success on intelligence tests--as noted by Goodenough and Karp in 1961 and others subsequently. It is, however, with the subtests themselves that the differences in ability, and perhaps in cognitive style, between LD children and their schoolmates are likely to be found, and it is to the description of those subtests that the task now turns.

The Verbal Subtests of the Wechsler Scales

Performance on the verbal subtests is a function of an individual's ability with both receptive and expressive language. He or she must be able to obtain meaning from language and to make meaningful utterances in language to score well. He or she must comprehend a world structured in language and be able to restructure that linguistic world. The Verbal Scale is the scale most influenced by cultural and environmental factors. Kaufman notes that the Verbal Scale is a good measure of Cattell's crystallized ability

(1979, p. 28). It is this scale which is most closely related to successful achievement in school. Bannatyne's Acquired Knowledge category which includes Information, Arithmetic, and Vocabulary is a measure of an individual's ability to do school type tasks, and it is drawn entirely from the Verbal Scale (1968). Description of the Verbal Scale subtests follows. The information developed is based essentially on the analyses provided by Sattler (1982, pp. 577 - 582) and Kaufman (1979, pp. 102 - 109). Exceptions will be noted.

Information: According to Kaufman, the unique ability measured by the Information subtest is the range of general factual knowledge an individual possesses, and, it should be added, can recall and present verbally on demand. Long-term memory is thought to be an essential ability underlying the acquisition and possession of a broad range of information. Sattler suggests that alertness to the environment, intellectual curiosity, and ambitiousness also influence a person's score on the Information subtest. A person's cultural and environmental surroundings and background are also important influences.

Similarities: The unique ability measured by the Similarities subtest is the ability to think in a logical abstractive manner, i.e., to categorize on the basis of linguistically encoded categories or, more simply, to use verbal concepts. Included are the abilities to reason both concretely and abstractly, to separate essential from nonessential details, and to verbalize appropriate relationships between objects or concepts. Memory for verbal concepts and rules of categorization is required as is flexibility of thought processes.

Arithmetic: The unique abilities measured by the Arithmetic subtest are numerical reasoning and mental computation. Concentration, attention, memory, and the application of the basic arithmetic operations are also required. Bannatyne suggests that the Arithmetic subtest is also a measure of sequencing ability (1974).

Vocabulary: Kaufman asserts that the Vocabulary subtest uniquely measures language development and word knowledge. Sattler notes that learning ability, memory, and the extent of an individual's fund of information are also important. The ability to form verbal concepts also plays a role in determining Vocabulary scores.

Comprehension: The ability to demonstrate practical information and to evaluate and use past experiences are the unique abilities measured by the Comprehension subtest. It assesses social judgment and common sense as well as knowledge of the accepted standards of behavior. High scores will also require good expressive language skills.

Digit Span: The unique ability measured by the Digit Span test is short-term auditory memory of unrelated units of information. Attention, concentration, and auditory sequencing are additional requirements of satisfactory performance on this subtest. A facility with numbers may contribute positively as well.

The Performance Subtests of the Wechsler Scales

The Performance subtests are, according to Sattler, "more dependent [than are the Verbal subtests] on the child's immediate problem-solving ability and require the child to meet new situations and apply past experience and previously acquired skills to a new set of demands" (p. 199). The input the testee receives in the Peformance subtests is primarily visual and the responses required are, for the most part, visual-motor responses. Nonverbal reasoning, gestalt production and manipulation, and spatial ability are essential features of success on the Performance subests. The tests are a reasonable measure of Cattell's fluid intelligence, and as such are less influenced by cultural and environmental factors than are the subtests of the Verbal Scale.

Picture Completion: Kaufman suggests that the unique abilities assessed by this subtest are visual alertness and visual recognition and identification--both factors of long-term visual memory. Other important aspects of this subtest are holistic processing ability and the ability to differentiate essential from nonessential details in a set of visual stimuli. Perception of figure-ground relationships is also important.

Picture Arrangement: Picture Arrangement assesses an individual's ability to anticipate consequences in a visually presented social situation, and his or her ability to sequence temporally. The subtest also requires planning ability, alertness to detail, evaluation of social situations, and common sense.

Block Design: Analysis of a whole into its component parts, nonverbal concept formation, and spatial visualization are the unique abilities measured by the Block Design subtest. It requires as well an ability to synthesize parts into a whole and visual-motor coordination. Block Design is the best measure of *g* in the Performance Scale and is the test most sensitive to cognitive impairment as a result of brain damage.

Object Assembly: Kaufman lists the following as unique abilities assessed by the Object Assembly subtest: ability to benefit from sensory-motor feedback, the anticipation of relationships among parts, and flexibility. Sattler notes the ability to synthesize concrete parts into meaningful wholes and visual-motor coordination are important in successful performance on this subtest.

Coding: The ability to follow directions, speed and accuracy on clerical type tasks, psychomotor speed and short-term visual memory are measured by the Coding (both A and B) subtests. Additionally, facility of performance on this subtest requires visual-motor coordination and/or dexterity, attentional skills, and symbol-associative skills. In at least one study (Dean, 1983), Coding has been shown to be one of the most accurate predictors of nonverbal learning ability.

Mazes: This subtest measures planning ability, eye-hand coordination, pencil and paper skill, and the ability to use foresight in the execution of a task. The subtest also demands adequate spatial perception.

This concludes the review of the Wechsler Scales and attention is now turned to the instrument used to assess cognitive style in this investigation: The Group Embedded Figures Test.

The Group Embedded Figures Test

The Group Embedded Figures Test is one of several measures of psychological differentiation or field dependence developed by Witkin, Oltman, Raskin and Karp (1971). The test, like its close relatives, the Embedded Figures Test (an individual test) and the Children's Embedded Figures Test, assesses psychological differentiation as a factor of the time required to apprehend a simple geometric figure embedded within a more complex figure. Field independent, articulated, or psychologically differentiated persons are able to correctly apprehend the simple embedded figures more quickly than are field dependent, global, or relatively undifferentiated individuals.

The test is comprised of 25 problem figures. The first seven of figures are relatively simple and nearly all students can apprehend and trace all seven of the simple figures in the two minutes allowed. The test is scored on the basis of the remaining 18 problems. These problems are divided into two sets of nine problems and the testees are allowed five minutes for each set. The test is scored by counting the number of correctly traced simple figures completed in the time allowed. The maximum score obtainable is 18.

The GEFT is not well normed and the norms which are provided in the manual (p. 28) are for college students. Table 5-2 recapitulates the norms provided.

TABLE 5-2

NUMBER CORRECT: GEFT

Quartiles	Men	Women
1	0-9	0-8
2	10-12	9-11
3	13-15	12-14
4	16-18	15-18
N	155	242
Mean	12.0	10.8
S.D.	4.1	4.2

The test was re-normed for the purposes of this investigation on 100 students (42 girls and 58 boys) drawn at random from nine grade 8 and 9 classes in a Strathcona County junior-senior high school. The new norms established are, then, based on the same age group as the research group. The average age of the norming sample was 14-5 which compares favourably to the mean age of 14-11 years for the research group and the 14-3 mean age of the comparison group. The results obtained conform to previously established trends: the Grade 9 students were more field independent than the Grade 8 students; the boys were more field independent than the girls. The Grade 9's mean score was 10.65 (SD 4.35) while the Grade 8's mean score was 9.19 (SD 4.57); the boy's mean score for both grades was 10.5 (SD 4.66) and the girls mean was 9.36 (SD 4.14). The percentile ranks for boys and girls in the junior high school norming are presented in Table 5-3.

TABLE 5-3

GEFT NORMING RESULTS -- JUNIOR HIGH SCHOOL SAMPLE

SCORE	PERCENTILE - BOYS	PERCENTILE - GIRLS
18	99	99
17	96	97
16	90	96
15	84	92
14	77	87
13	69	81
12	60	75
11	53	68
10	50	61
9	39	50
8	33	45
7	27	41
6	23	33
5	17	22
4	13	9
3	9	5
2	5	2
1	3	1
1st Quartile	0-6	0-5
2nd Quartile	7-10	6-9
3rd Quartile	11-13	10-12
4th Quartile	14-18	13-18
Number	58	42
Mean	10.50	9.36
S.D.	4.66	4.14

A reliability estimate was obtained for girl's scores, boy's scores, and for the total group using the Spearman-Brown Prophecy Formula. Although the test manual suggests that Parts 2 and 3 are equivalent, it was thought some practice effect might influence scores and the reliability estimate was based on an odd-even split. The scores used were obtained from Parts 2 and 3 (Part 1 is an unscored practice section). Problems 1, 3, 5, 7, and 9 were used from Part 2 and problems 2, 4, 6, and 8 from Part 3 as the odd numbered problems. The problems used from Part 3 correspond to questions 11, 13, 15, and 17 if the whole test were numbered sequentially throughout rather than Part 3 beginning at number 1 again. Satisfactory estimates of reliability were obtained for girls, boys, and total sample. Those estimates were girls 0.80, boys 0.90 and total sample 0.86. The standard error of measurement was calculated to be 1.67. The values obtained here fall within acceptable values and the norms established should be considered reliable for this age group.

The results obtained approximate those reported by Shade (1983). While she does not report a single mean for boys or girls, the means reported for Grade 9 students at three achievement levels suggest a "blended" mean that would approximate those reported here. Her results were as follows: High Achievers --males 13.08 (N = 25), females 9.64 (N = 36); Average Achievers --males 8.64 (N = 14), females 9.07 (N = 14); Low Achievers --males 5.86 (N = 21), females 4.46 (N = 25). On the basis of their comparability with Shade's results and the fit with the college norms, the results obtained from the local junior high norming sample seem satisfactory and will be used to classify students on the field dependence-independence dimension.

PRODCEDURE

Students were selected to participate in the research group according to the following criteria: the student (1) had been tested with the CAT within the last two years at the grade seven or eight level; (2) had been assessed with the WISC-R within three years of the date on which he or she wrote the CAT; (3) had been referred for WISC-R testing on the basis of some perceived learning difficulty by classroom teachers and/or parents; and (4) had achieved a IQ score equal to or greater than 90 on at least one of the Performance or Verbal Scales. A small comparison group was selected from students who had WISC-Rs on file as a result of having been referred to the Challenge or some other program having superior intelligence as an admission criteria. The criteria that the WISC-R assessment was within three years of the CAT administration was not observed for this group. As with the research group, CATs administered during the student's Grade 7 or 8 year were selected to be compared with the WISC-Rs.

The school records of students in eight Strathcona County public junior high schools were examined and a data sheet was opened for each student conforming to the criteria outlined in the previous paragraph. Two hundred sixteen students had records which meet the critera established for the research group. Another 31 students were selected for the comparison group. When the students were identified, permission was obtained to administer the GEFT. Students had the choice of participating or opting out of the GEFT testing. Twenty-eight children in the research group and two in the comparison group either declined the opportunity to challenge the GEFT or were absent on the day the test was administered in their schools. A total of 217 students wrote the GEFT: 188 from the research group and 29 from the comparison group.

Because the students in the research group were referred for WISC-R testing on the basis of learning difficulties, GEFT administration procedures were modified slightly to accommodate the poorer readers expected in the sample. The GEFT manual directions begin by instructing the student "Now start reading the Directions, which include 2 practice problems . . ." (p. 27). Those instructions were modified to include the instruction "Read to yourself as I read aloud" and all directions were read to the students. All GEFT administrations were by the author and all, including the norming sample administrations, followed the format outlined above. Following the testing, the Group Embedded Figures Tests were scored by the author and the raw scores and percentile ranks--according to locally established norms--were added to the data sheets.

ANALYSES

Hypothesis I asserts that homogeneous subgroups of children showing distinctive WISC-R profiles will emerge from the larger heterogeneous group of children with learning difficulties. It is suggested that the bases for the homogeneous groups will be strength or weakness in the content/skill areas assessed by the CAT. The following procedures will be used to test the hypothesis advanced. CAT subtest standard scores will be converted to _z_ scores and classified as demonstrating strength or weakness in a content/skill area. Strength and weakness are defined by a _z_ score that is greater or lesser, respectively, than the Total Battery score by an amount equal to or greater than one standard deviation, i.e., one _z_-score unit. (In the event that this definition yields an insufficient number of cases per category, it will be adjusted to define strength or weakness in terms of some decimal fraction of the _z_ score; however, in no case will the re-defined score be less than plus or minus 0.5 _z_ units.) This initial operation will establish the homogeneous subgroups among which the WISC-R profiles will be compared. There are sixteen potential categories: strength in each of the eight subtests of the CAT and weakness in each subtest.

The students' WISC-R results will be sorted, according to the criterion established above, into the CAT division or category in which each result demonstrates strength or weakness. Some profiles will show no unusual strength or weakness relative to the Total Battery score; some profiles will show strength or weakness in more than one area; and some profiles will show both strengths and weaknesses. In those cases where strength or weakness is shown in more than one area, the WISC-R results will be sorted in such a way to allow all of combinations strength or weakness to appear. Means for WISC-R IQs and subtests will be calculated for each CAT division and analysis of variance and/or t tests will be used to determine significant differences. Mean GEFT scores for each CAT category will also be calculated. T tests and/or analysis of variance will be used to determine statistically significant differences among the subtests in the various CAT divisions.

Hypothesis II predicts that field independent students will show greater ability, as measured by the WISC-R, and greater achievement, as measured by the CAT, than field dependent students. GEFT results will be divided into quartiles. The first quartile will be the most field dependent students; the second and third quatiles will be the "field middle" students; and the fourth quartile will be the most field independent students. WISC-R IQ means and subtest means as well as CAT subtest means will be calculated for each quartile by total group, (males and females together), male group, female group, and the comparison group. The group quartile means will be examined for statistically significant differences through t tests and analysis of variance as each procedure is appropriate.

A subsidiary hypothesis, Hypothesis IIA, suggests positive and negative associations between field dependence or independence and certain subsets of WISC-R subtests. The hypothesized relationships will be studied through an examination of the correlations between the composite scores of the subtests and GEFT scores. The subsets to be examined are the Spatial triad (PC, BD, and OA), the Third factor (A, Ds, and C), an analysis dyad (S and BD), the ACID profile, a VIDA profile, and each of the WISC-R IQ scores. A separate analysis will be done for each of the total research group, the male research group, the female research group, and the comparison group.

Finally, Hypothesis IIB predicts interactions among ability, achievement, and field dependence results. Significant main effects, between groups effects, and interactions will be sought through a multivariate analysis of variance in a CAT division by WISC-R subtest by GEFT score matrix. Such other statistical analyses will be performed as suggest themselves in the results of the procedures discussed in the foregoing paragraphs.

CHAPTER 6

RESULTS AND DISCUSSION:
WISC-R PROFILES

CHANGES

Initial data analysis suggested some changes in methodology were desirable. The high IQ comparison group yielded only two to three cases per cell. It was decided that there were too few cases in each of the critical cells, i.e., the strong and weak cells, to provide meaningful results, and further analysis of that group was not carried forth. In the analysis of WISC-R profiles according to strength and weakness on the CAT subtests, the group which showed neither exceptional strength or weakness will serve as the comparison group.

While it was decided that strength or weakness in a particular CAT subtest would be based on a deviation of one or more *z*-score units, or as a worst case senario, a 0.5 *z*-score deviation, it was hoped that a greater deviation would more cleanly delineate groups. The initial analysis was based on two *z*-score units. That analysis showed that two *z*-score deviations between CAT subtest scores and the Total Battery score would create too few cases per cell to yield meaningful results in some of the analyses planned. An examination of the results initally obtained suggested that a cut of the top and bottom ten percent in terms of _z_-score deviations from the Total Battery score would be a reasonable compromise which would yield an acceptable number of cases in each cell and would at the same time represent real differences in terms of achievement on the Canadian Achievement Test subtests. _Z_ scores corresponding to the tenth and ninetieth percentiles were calculated, and those scores were entered as the cut points for weakness and strength respectively for each of the CAT subtests. The _z_ scores used are set out in Table 6-1.

TABLE 6-1

_Z_ SCORES MARKING THE TENTH AND NINETIETH PERCENTILES FOR CAT SUBTESTS: MEAN DEVIATIONS AND RANGES INCLUDED

SUBTEST	10TH %ILE	90TH %ILE	DIFFERENCE
Reading Vocabulary	-1.439	2.343	3.782
Reading Comprehension	-1.185	1.907	3.092
Spelling	-1.525	1.749*	3.274
Language Mechanics	-1.430	2.016	3.446
Language Expression	-1.478	1.611	3.089
Math Computation	-1.855	1.981	3.836
Math Concepts & Appl.	-1.312	1.903	3.215
Reference Skills	-1.476	1.860	3.336
Mean Deviation	-1.463 (0.19)	1.921 (0.21)	
Mean Difference			3.384 (0.29)
Ranges			
	-1.185 (RC)	1.611 (LE)	3.089 (LE)
	-1.855 (MC)	2.343 (RV)	3.836 (MC)
Difference	0.670	0.732	0.747

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[*] As a result of a coding error, the actual value entered in calculations of CAT strength was 2.243, approximately the 97th percentile.

It seems reasonable to assert that students whose performance in specific content/skill areas falls almost one and one-half deviations below their mean achievement level are, or function as though they are, learning disabled in that content/skill area. It also seems appropriate to assert that those who score in the top ten percent--the equivalent of almost two deviations in this case--of a specific content/skill area are truly superior in that area. This approach should lay to rest any questions regarding whether the students in the sample are "really" learning disabled. Each child in the low or weak group shows a learning deficit in a certain content/skill area and all groups exhibit IQ scores that fall into the Average classification.

THE SAMPLE

There are in effect two overlapping samples included in the analyses. There is a sample of 216 students for those analyses in which field dependence was not an element. For those procedures that include field dependence, the sample size is 188. The WISC-R IQ and subtest scaled scores for each sample differ only in tenths of a point and are not presented separately here. The WISC-R mean scores for the total group are presented as Table 6-2.

The table indicates that the group as a whole has a higher Performance than Verbal IQ. The difference of 8.46

TABLE 6-2

WISC-R IQ AND SCALED SCORE MEANS FOR TOTAL SAMPLE (N=216)

WISC-R Full Scale IQ Score	99.93	(8.51)
Verbal IQ Score	96.23	(9.16)
Performance IQ Score	104.69	(11.09)

Verbal Subtests		S.D.	Performance Subtests		S.D.
Information	8.72	2.15	Picture Completion	10.42	2.50
Similarities	9.87	2.36	Picture Arrangement	11.02	2.63
Arithmetic	9.38	2.23	Block Design	10.91	2.71
Vocabulary	9.36	1.90	Object Assembly	11.14	2.82
Comprehension	9.87	1.99	Coding	10.21	2.50
Digit Span	8.74	2.38	Mazes	Not done	

IQ points approaches significance at the 85 percent level of confidence (for a difference of 9 scaled score points $p<0.15$). Hence it may be said that the total group tends to Performance greater than Verbal IQ scores but at levels of confidence that are not usually accepted as great enough to reject the null hypothesis. The total group then represents children of Average IQ who show normal differences in Verbal and Performance IQ scores. There should be no suggestion that the effects obtained result from the inclusion of children of subnormal IQ. The profile for the total group is graphed in Figure 6-1. The Full Scale IQ range was from 128 (VIQ 119; PIQ 131) to 82 (VIQ 77; PIQ 91).

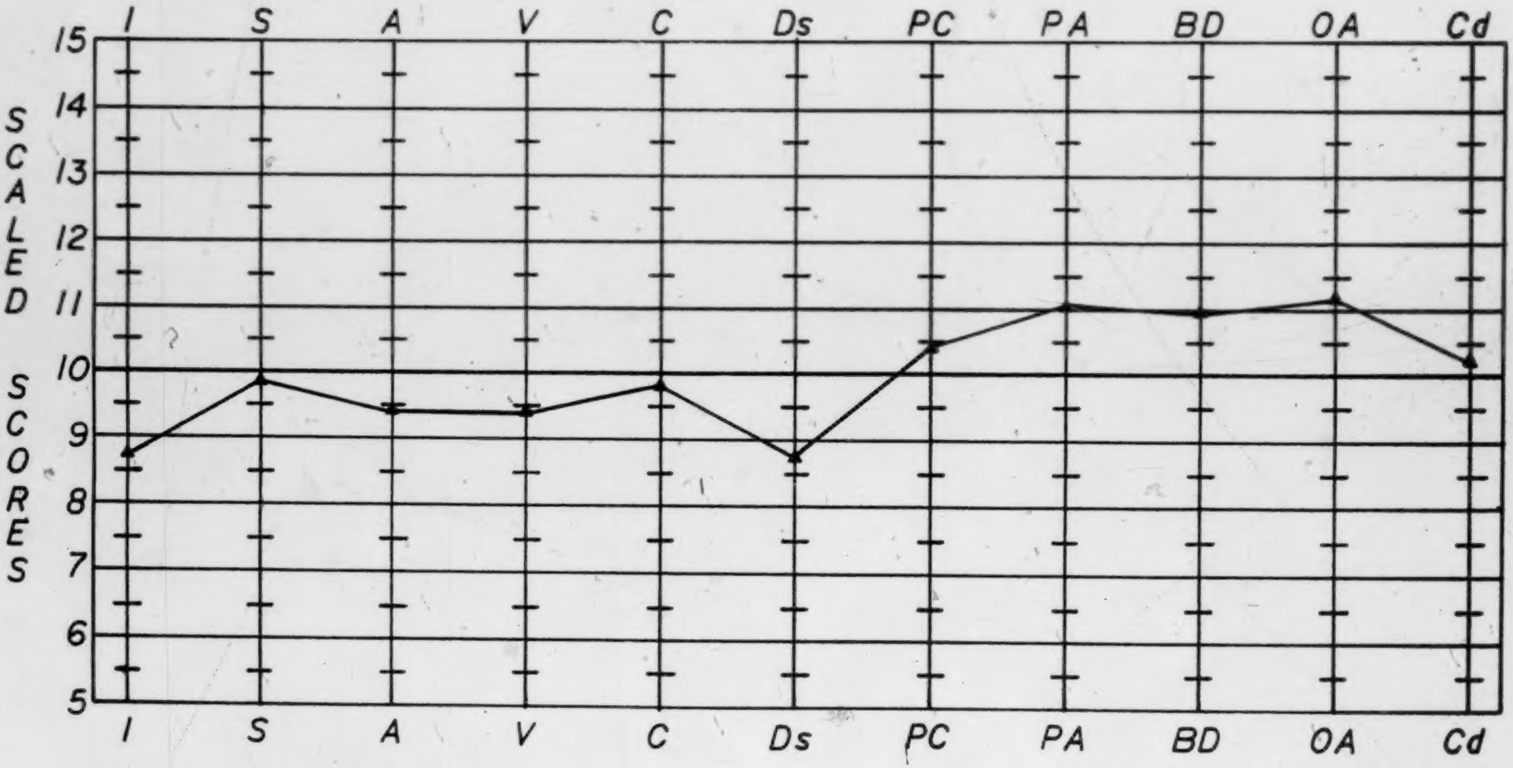
HYPOTHESIS I: WISC-R PROFILES

RESULTS - A METHODOLOGICAL CONCERN

An immediate methodological problem arises in determining whether this hypothesis is supported. The problem is one of

FIGURE 6-1

WISC-R PROFILE: TOTAL GROUP



▲ = Difference significant at $p \leq 0.05$

what criteria are to be used to decide if a profile is truly distinctive. It is not expected that every subtest of the WISC-R should show significant differences between the strong and weak groups inasmuch as certain abilities will apply across several content/skill areas. On the other hand, it is not the case that certain WISC-R subtests can be specified a priori as those about which distinctiveness will turn for that is a central question of this research. The issue to be decided is how many subtests must differ significantly before a profile may be considered distinctive.

Two of the most frequently used techniques for interpreting WISC-R profiles, Bannatyne's and Kaufman's analyses, are based on groups of three and four WISC-R subtests. Further, Kaufman suggests a number of combinations of subtests to consider in interpreting Verbal and Performance subtests of the WISC-R (1979, pp. 142 - 170). For the most part, those subtests fall into groups of three, e.g., reasoning ability is shown in the Similarities, Arithmetic, and Comprehension; recall ability is demonstrated in the Information, Vocabulary and Digit Span subtests. In all he lists nine groups of three, four groups of two, and three groups of four subtests which mark special abilities. These observations suggest that three significantly different subtests is a reasonable number on which to base a distinctive profile. The following operational definition will be used: when a profile contains three or more subtests which differ significantly with $p \leq 0.05$ in either main effects or interaction effects, that profile will be considered distinctive or characteristic of strength or weakness in a given content/skill area.

On the basis of the operational definition given above, the hypothesis that distinctive profiles will emerge for (1) language strength, (2) language weakness, (3) mathematics strength, (4) mathematics weakness, and (5) language-mathematics weakness is partially supported. Strong and weak language profiles and strong and weak mathematics profiles are exhibited. No profile suggesting weakness in both language and mathematics appears. Further, Spelling strength and weakness profiles which were not hypothesized (but which in hindsight should have been) seem to be demonstrated. Finally, the Language Mechanics subtest of the CAT yields a WISC-R profile which, while not distinctive by the criterion set out, is interesting in its own right.

RESULTS - CAT SUBTESTS BASED ON VISUAL RECEPTIVE LANGUAGE

Success in four of the CAT subtests rests primarily on visual language reception abilities; although, each measures a different aspect of that skill or ability. Those subtests are Reading Vocabulary, Reading Comprehension, Language Expression, and Reference Skills. Strength, relative to Total Battery scores, in each of these yields a similar

WISC-R profile. The profiles differ in their distance above or below the WISC-R mean scaled score of 10 but the pattern of peaks and valleys is essentially preserved thoughout the four subtests. On the WISC-R Verbal subtests, the visual language reception group of CAT subtests shows peaks on Similarities, Vocabulary, and Comprehension. On the Performance subtests, the peaks occur on Picture Arrangement and Object Assembly with Picture Completion a near third. The low scores on the Verbal subtests are, with one exception, the Arithmetic and Digit Span scores. Low scores for the Performance subtests are on Block Design and Coding. Figures 6-2 through 6-5 illustrate the profiles described. The graphs are accompanied by Tables 6-3 through 6-6. from which the data graphed is drawn.

Weakness in the CAT visual language reception group produces a profile that is less homogenous than is that of the strong group and, interestingly, the subtests on which it differs significantly from the strong profile are found among the Performance subtests. On the two Reading tests, the weak groups tends to show low Information scores then a plateau between Similarities and Arithmetic, a trough at Vocabulary, a rise to Comprehension, and no particular pattern with regard to Digit Span (the profile rises with one and declines with the other). The Language Expression and Reference Skills subtests lack the plateau between Similarities and both decline from Comprehension to Digit

Span. The Performance side of the profile is somewhat more consistent with only one deviant CAT division. In general, the profile rises from Picture Completion through Picture Arrangement and Block Design to a high at Object Assembly and then declines with Coding to a level approximately equal to Picture Completion.

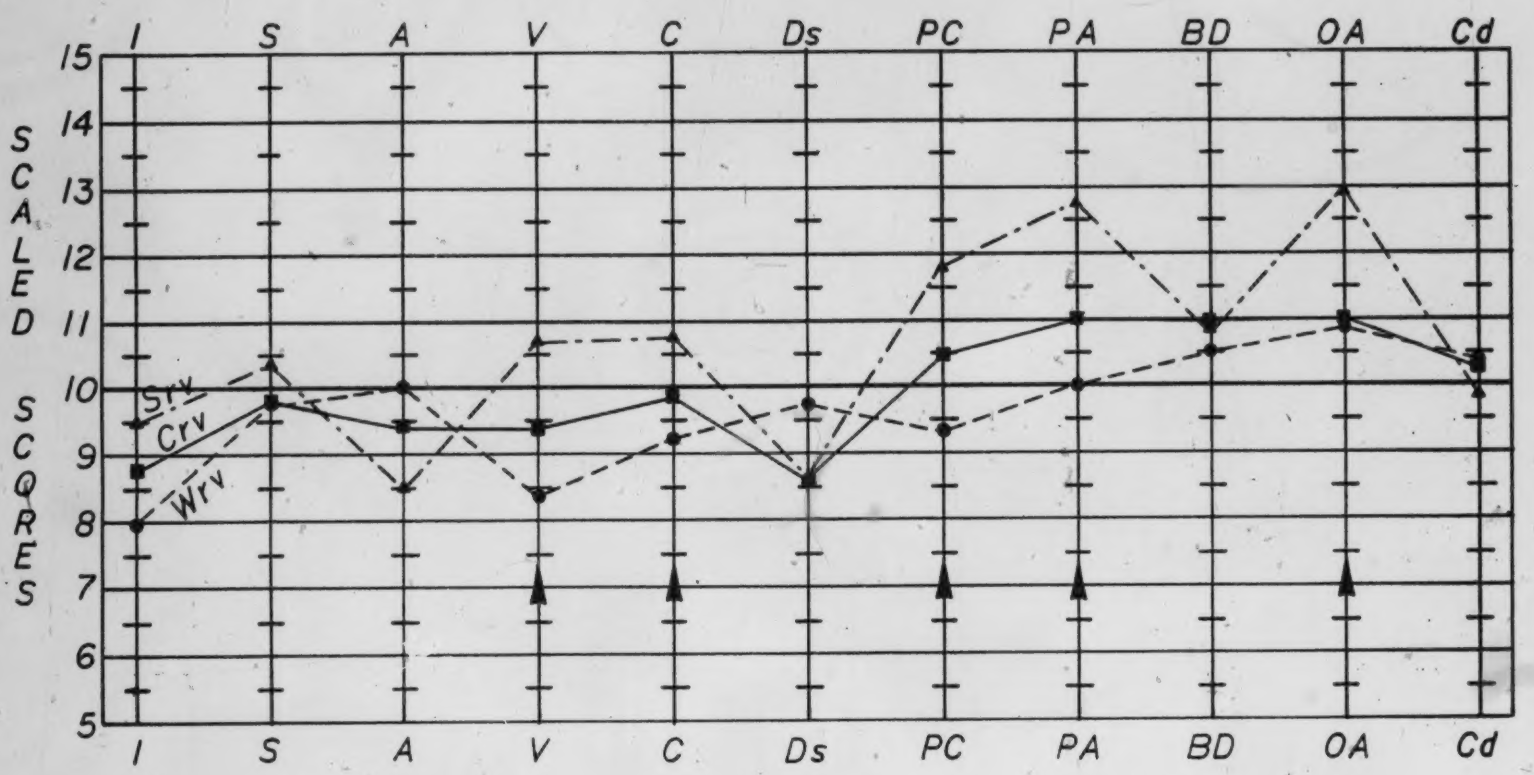
The differences between groups are best observed on the graphed profiles. Tables of mean WISC-R IQ and subtest scaled scores for the various CAT divisons and the number of cases in each cell (strong, mid-range, and weak) are presented with the graphs. The graphs plot the scaled scores of the WISC-R subtests for each CAT subtest division, that is, each graph plots the strong, comparison (mid-range), and weak groups. The average number of cases for each cell is as follows: strong 21, mid-range 174, and weak 21. Exact numbers for each CAT division are given in the tables accompanying the graphs. The following convention will be used to designate the cell or cells being described or discussed when frequent repetitions of cell labels are required: Strong, Weak or Comparison will be designated with an upper case S, W, or C, respectively, and the CAT subtest on which the division is based will be indicated in lower case letters. The strong group of the Reading Vocabulary subtest will, for example, be designated as Srv, the intermediate group as Crv, the weak group as Wrv. A list of the codes and the CAT subtests which they designate is presented as Table 6-7.

The CAT Reading Vocabulary division yields the strongest differences between the strong and weak groups. One way analysis of variance shows significant differences between the Reading Vocabulary strong and weak groups on five WISC-R subtest means. Anova tables for these results are presented as Table 6-8 through Table 6-12. The following significant differences are observed: Vocabulary - overall difference $p=0.0004$, between the Srv and Crv groups $p\leq0.05$ and between the Srv and Wrv groups $p\leq0.01$; Comprehension - overall difference $p=0.26$, difference between Srv and Wrv groups $p\leq0.05$; Picture Completion - overall difference $p=0.006$, difference between Srv and Wrv group at $p\leq0.05$; Picture Arrangement - overall difference $p=0.003$, difference between Srv and Wrv group $p\leq0.01$; Object Assembly - overall $p=0.021$, between Srv and Crv group $p\leq0.05$ (actual scores: Srv group = 12.89, Crv group = 11.00, Wrv group = 10.86).

Division on the basis of Reading Comprehension results in a significant difference between the weak and strong groups only on WISC-R Arithmetic. The overall difference in means is significant at $p=0.001$ (see Table 6-13), and the difference between the Wrc group and the Src group, and between the Wrc group and the Crc group is in both cases significant at $p\leq0.01$. Division by strength and weakness

FIGURE 6-2

WISC-R PROFILE: READING VOCABULARY



▲ = Difference significant at $p \leq 0.05$

TABLE 6-3

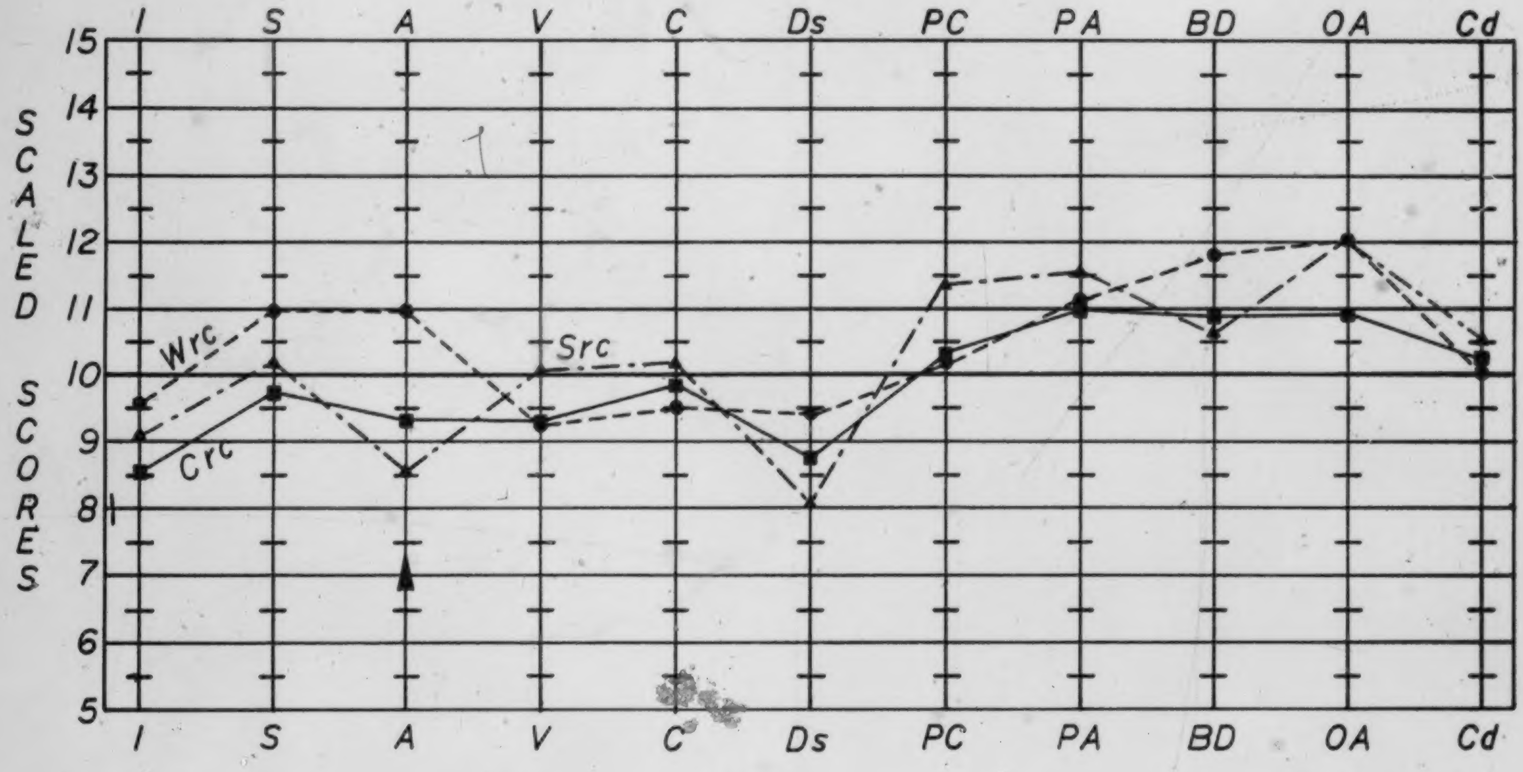
READING VOCABULARY CAT DIVISION WISC-R PROFILE

WISC-R IQ SCALE	WEAK RV SCORE (SD) (N = 22)	MID RV SCORE (SD) (N = 176)	STRONG RV SCORE (SD) (N = 18)
Full Scale	96.55 (8.59)	99.84 (8.15)	105.00 (9.94)
Verbal	93.82 (7.34)	96.20 (9.17)	99.44 (10.50)
Performance	101.14 (12.72)	104.49 (10.68)	110.89 (11.10)

WISC-R SUBTEST	WEAK RV SCORE (SD)	MID RV SCORE (SD)	STRONG RV SCORE (SD)
VERBAL			
Information	7.91 (2.07)	8.74 (2.15)	9.50 (2.03)
Similarities	9.82 (1.71)	9.83 (2.39)	10.33 (2.77)
Arithmetic	10.00 (2.45)	9.39 (2.21)	8.50 (1.89)
Vocabulary	8.36 (1.65)	9.34 (1.82)	10.72 (2.22)
Comprehension	9.14 (1.64)	9.86 (1.96)	10.83 (2.33)
Digit Span	9.73 (2.23)	8.63 (2.34)	8.67 (2.79)
PERFORMANCE			
Picture Comp.	9.32 (2.92)	10.41 (2.36)	11.83 (2.77)
Picture Arr.	9.95 (3.46)	10.98 (2.42)	12.78 (2.76)
Block Design	10.50 (2.60)	10.97 (2.76)	10.83 (2.41)
Object Assem.	10.86 (3.12)	11.00 (2.76)	12.89 (2.52)
Coding	10.36 (2.24)	10.23 (2.53)	9.83 (2.57)

FIGURE 6-3

WISC-R PROFILE: READING COMPREHENSION



▲ = Difference significant at $p \leq 0.05$

TABLE 6-4

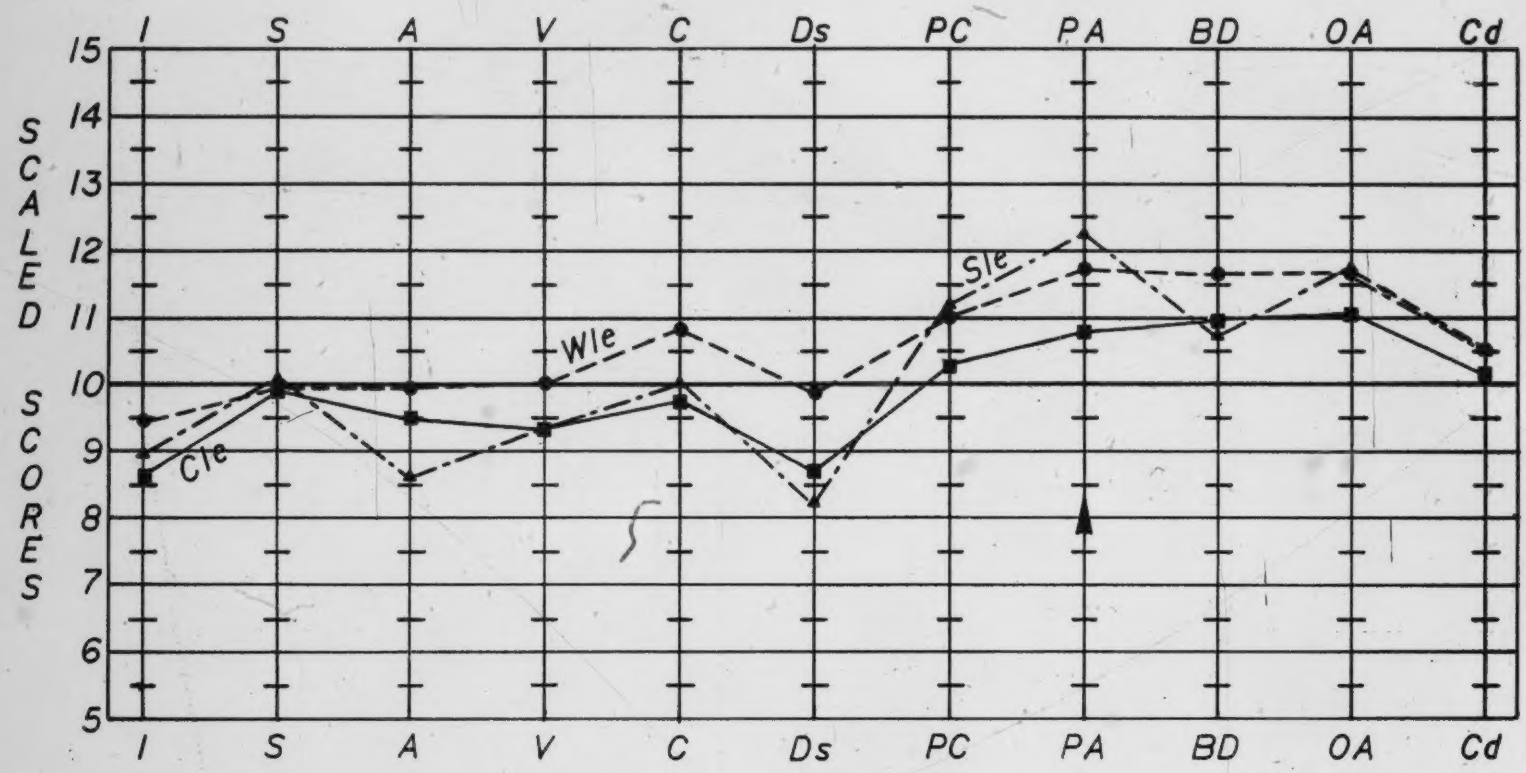
READING COMPREHENSION CAT DIVISION WISC-R PROFILE

WISC-R IQ SCALE	WEAK RC SCORE (SD) (N = 21)	MID RC SCORE (SD) (N = 172)	STRONG RC SCORE (SD) (N = 23)
Full Scale	103.29 (9.12)	99.22 (8.35)	102.22 (8.29)
Verbal	100.10 (7.82)	95.64 (9.20)	97.09 (9.45)
Performance	106.67 (13.55)	103.97 (10.58)	108.26 (11.99)

WISC-R SUBTEST	WEAK RC SCORE (SD)	MID RC SCORE (SD)	STRONG RC SCORE (SD)
VERBAL			
Information	9.62 (1.56)	8.56 (2.18)	9.09 (2.25)
Similarities	10.95 (2.13)	9.70 (2.39)	10.13 (2.10)
Arithmetic	10.90 (2.00)	9.30 (2.20)	8.52 (2.06)
Vocabulary	9.24 (1.30)	9.28 (1.92)	10.04 (2.10)
Comprehension	9.48 (2.27)	9.87 (1.99)	10.17 (1.67)
Digit Span	9.38 (2.69)	8.76 (2.38)	8.04 (1.99)
PERFORMANCE			
Picture Comp.	10.10 (3.03)	10.33 (2.42)	11.35 (2.50)
Picture Arr.	11.10 (3.02)	10.94 (2.62)	11.57 (2.36)
Block Design	11.81 (3.64)	10.83 (2.58)	10.65 (2.71)
Object Assem.	12.00 (3.18)	10.92 (2.68)	12.00 (3.23)
Coding	10.00 (2.93)	10.20 (2.40)	10.52 (2.86)

FIGURE 6-4

WISC-R PROFILE: LANGUAGE EXPRESSION



▲ = Difference significant at $p \leq 0.05$

TABLE 6-5

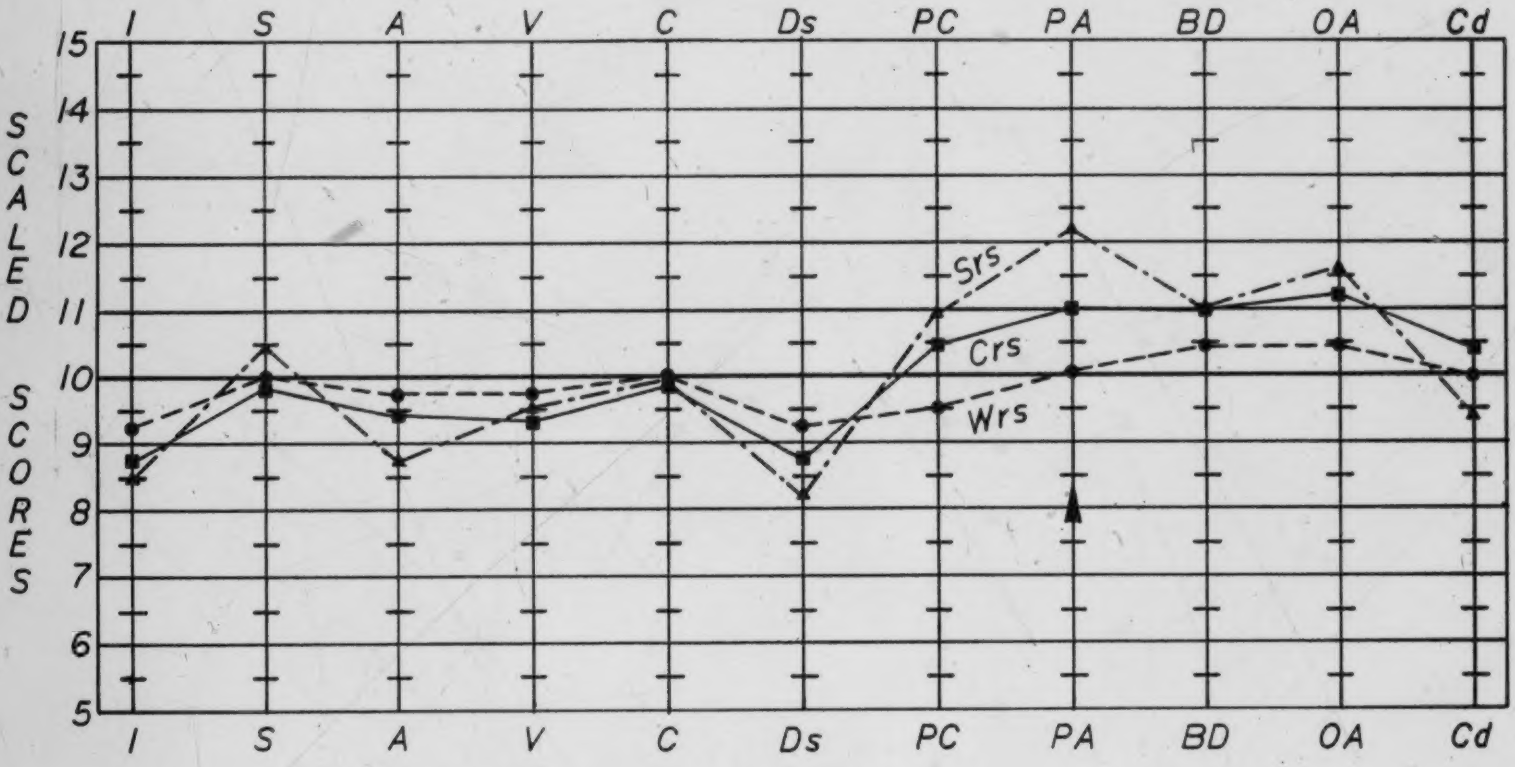
LANGUAGE EXPRESSION CAT DIVISION WISC-R PROFILE

WISC-R IQ SCALE	WEAK LE SCORE (SD) (N = 20)	MID LE SCORE (SD) (N = 172)	STRONG LE SCORE (SD) (N = 24)
Full Scale	103.95 (9.00)	99.25 (8.40)	101.45 (8.04)
Verbal	99.65 (9.07)	95.88 (9.24)	95.88 (8.36)
Performance	108.80 (11.50)	103.67 (10.73)	108.50 (12.09)

WISC-R SUBTEST	WEAK LE SCORE (SD)	MID LE SCORE (SD)	STRONG LE SCORE (SD)
VERBAL			
Information	9.40 (2.46)	8.62 (2.15)	8.88 (1.83)
Similarities	9.90 (2.15)	9.84 (2.39)	10.08 (2.34)
Arithmetic	9.90 (2.25)	9.42 (2.27)	8.63 (1.74)
Vocabulary	10.00 (2.13)	9.29 (1.89)	9.29 (1.76)
Comprehension	10.80 (2.46)	9.74 (1.93)	10.00 (1.79)
Digit Span	9.85 (3.45)	8.69 (2.21)	8.21 (2.32)
PERFORMANCE			
Picture Comp.	11.00 (1.86)	10.24 (2.38)	11.17 (3.49)
Picture Arr.	11.70 (3.37)	10.78 (2.46)	12.21 (2.81)
Block Design	11.60 (2.39)	10.85 (2.77)	10.71 (2.56)
Object Assem.	11.60 (2.74)	11.02 (2.75)	11.67 (3.32)
Coding	10.55 (2.58)	10.13 (2.57)	10.54 (1.89)

FIGURE 6-5

WISC-R PROFILE: REFERENCE SKILLS



▲ = Difference significant at $p \leq 0.05$

TABLE 6-6

REFERENCE SKILL CAT DIVISION WISC-R PROFILE

WISC-R IQ SCALE	WEAK RS SCORE (SD) (N = 20)	MID RS SCORE (SD) (N = 173)	STRONG RS SCORE (SD) (N = 23)
Full Scale	98.60 (8.71)	99.93 (8.38)	101.09 (9.51)
Verbal	98 05 (9.07)	96.05 (9.24)	95.96 (8.36)
Performance	99.60 (11.92)	104.99 (10.86)	106.78 (11.28)

WISC-R SUBTEST	WEAK RS SCORE (SD)	MID RS SCORE (SD)	STRONG RS SCORE (SD)
VERBAL			
Information	9.20 (1.91)	8.70 (2.18)	8.48 (2.19)
Similarities	10.00 (2.64)	9.78 (2.31)	10.39 (2.50)
Arithmetic	9.70 (2.09)	9.42 (2.25)	8.74 (2.14)
Vocabulary	9.70 (1.59)	9.29 (1.93)	9.52 (1.97)
Comprehension	10.00 (2.15)	9.84 (1.97)	9.91 (2.07)
Digit Span	9.20 (2.21)	8.76 (2.46)	8.17 (1.85)
PERFORMANCE			
Picture Comp.	9.50 (3.12)	10.46 (2.38)	10.91 (2.68)
Picture Arr.	10.05 (2.93)	10.98 (2.54)	12.17 (2.67)
Block Design	10.40 (2.56)	10.95 (2.74)	11.00 (2.68)
Object Assem.	10.40 (2.60)	11.16 (2.84)	11.65 (2.79)
Coding	9.95 (2.16)	10.36 (2.56)	9.35 (2.19)

TABLE 6-7

CODES DESIGNATING CAT SUBTEST DIVISIONS

CODE	CAT SUBTEST DIVISION
Reading Vocabulary	
Srv	Strong Reading Vocabulary
Crv	Mid-range Reading Vocabulary
Wrv	Weak Reading Vocabulary
Reading Comprehension	
Src	Strong Reading Comprehension
Crc	Mid-range Reading Comprehension
Wrc	Weak Reading Comprehension
Spelling	
Ssp	Strong Spelling
Csp	Mid-range Spelling
Wsp	Weak Spelling
Language Mechanics	
Slm	Strong Language Mechanics
Clm	Mid-range Language Mechanics
Wlm	Weak Language Mechanics
Language Expression	
Sle	Strong Language Expression
Cle	Mid-range Language Expression
Wle	Weak Language Expression
Mathematics Computation	
Smc	Strong Mathematics Computation
Cmc	Mid-range Mathematics Computation
Wmc	Weak Mathematics Computation
Mathematics Concepts and Application	
Smca	Strong Mathematics Concepts and Application
Cmca	Mid-range Mathematics Concepts and Application
Wmca	Weak Mathematics Concepts and Application
Reference Skills	
Srs	Strong Reference Skills
Crs	Mid-range Reference Skills
Wrs	Weak Reference Skills

TABLE 6-8

CAT GROUPS DIVIDED BY READING VOCABULARY; WISC-R VARIABLE: VOCABULARY

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	55.304	27.652	8.178	.0004
Within Groups	213	720.248	3.381		
Total	215	775.551			

TABLE 6-9

CAT GROUPS DIVIDED BY READING VOCABULARY; WISC-R VARIABLE: COMPREHENSION

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	28.567	14.283	3.717	.0259
Within Groups	213	818.540	3.843		
Total	215	847.107			

TABLE 6-10

CAT GROUPS DIVIDED BY READING VOCABULARY; WISC-R VARIABLE: PICTURE COMPLETION

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	62.682	31.341	5.216	.0061
Within Groups	213	1279.818	6.009		
Total	215	1342.500			

TABLE 6-11

CAT GROUPS DIVIDED BY READING VOCABULARY; WISC-R
VARIABLE: PICTURE ARRANGEMENT

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	80.910	40.455	6.146	.0025
Within Groups	213	1401.975	5.582		
Total	215	1482.884			

TABLE 6-12

CAT GROUPS DIVIDED BY READING VOCABULARY; WISC-R
VARIABLE: OBJECT ASSEMBLY

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	60.182	30.091	3.898	.0217
Within Groups	213	1644.369	7.720		
Total	215	1704.551			

on Language Expression shows a significant ($p=0.021$) difference on Picture Arrangement as set out in Table 6-14. The difference, however, is primarily between the strong group and the average group. Two other subtest differences approach the $p<0.05$ level of significance. The strong Language Expression group scored 8.21 on Digit Span and the average group scored 8.69, while the weak group scored 9.85. The difference is significant at $p=0.059$. Differences on the Comprehension subtest yield $p=0.07$. As with Digit Span, the difference between the average group and the strong

TABLE 6-13

CAT GROUPS DIVIDED BY READING COMPREHENSION; WISC-R VARIABLE: ARITHMETIC

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	66.797	33.399	7.129	.0010
Within Groups	213	997.828	4.685		
Total	215	1064.625			

TABLE 6-14

CAT GROUPS DIVIDED BY LANGUAGE EXPRESSION; WISC-R VARIABLE: PICTURE ARRANGEMENT

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	53.121	26.561	3.957	.0205
Within Groups	213	1429.763	6.713		
Total	215	1482.884			

TABLE 6-15

CAT GROUPS DIVIDED BY REFERENCE SKILLS; WISC-R VARIABLE: PICTURE ARRANGEMENT

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	49.682	24.841	3.692	.0265
Within Groups	213	1433.202	6.729		
Total	215	1482.884			

Language Expression group is small (0.26 scaled score points). The strong and weak groups of Reference Skills also showed significant differences (p=0.0265) in their Picture Arrangement scores as shown in Table 6-15.

Strength on the visual receptive language based subtests is not necessarily correlated with strength on the WISC-R. The strong Reading Vocabulary and strong Reference Skill groups score higher on Full Scale IQ than do the weaker counterparts. The score differences are, by analysis of variance, significant between Srv, Crv, and Wrv at p=0.0066 for Full Scale IQs. The differences for Reference Skill are not significant. For the Reading Comprehension and Language Expression divisions, the situation is reversed: the weak groups receive the higher Full Scale scores. In those cases, the significance levels between the three groups of Reading Comprehension and the three groups of Language Expression are p=0.046 and p=0.04, respectively. When Verbal IQs are considered, the strong groups score highest only on the Reading Vocabulary division. None of the visual receptive language based tests yields significant between-groups differences in Verbal IQ.

Performance IQs are greater for the strong group, in order of magnitude, on Reading Vocabulary, Reference Skills, and Reading Comprehension. Reading Vocabulary is significant at p=0.018. Neither of the two other subtests show significant differences. On Language Expression the strong and weak Performance scores are nearly equal: Sle is 108.8, Wle is 108.5. However, when all three scores in the Language Expression division are considered, the Performance scores also differ significantly (*p*=0.291). There is, nonetheless, one consistent pattern. In each case the strong group shows a greater difference between Verbal and Performance IQ than does the weak group, and in each case the strong CAT group exhibits a greater Performance IQ. The differences range from 10.82 points for Reference Skills to 12.62 ~~points~~ for Language Expression. These differences compare with a range of 1.55 for Reference Skills to 9.15 for Language Expression among the weak CAT groups. Anova results are reported in Tables 6-16 through 6-20.

TABLE 6-16

CAT GROUPS DIVIDED BY READING VOCABULARY; WISC-R
VARIABLE: FULL SCALE IQ

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	716.282	358.141	5.139	.0066
Within Groups	213	14845.676	69.698		
Total	215	15581.958			

TABLE 6-17

CAT GROUPS DIVIDED BY READING COMPREHENSION; WISC-R VARIABLE: FULL SCALE IQ

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	444.189	222.359	3.133	.0456
Within Groups	213	15117.240	70.973		
Total	215	15561.958			

TABLE 6-18

CAT GROUPS DIVIDED BY LANGUAGE EXPRESSION; WISC-R VARIABLE: FULL SCALE IQ

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	458.800	229.400	3.235	.0413
Within Groups	213	15103.158	70.907		
Total	215	15561.958			

TABLE 6-19

CAT GROUPS DIVIDED BY READING VOCABULARY; WISC-R
VARIABLE: PERFORMANCE IQ

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	976.230	488.115	4.085	.0182
Within Groups	213	25450.363	119.485		
Total	215	26426.593			

TABLE 6-20

CAT GROUPS DIVIDED BY LANGUAGE EXPRESSION; WISC-R
VARIABLE: PERFORMANCE

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	863.625	431.813	3.598	.0291
Within Groups	213	25562.967	120.014		
Total	215	26426.593			

In summary, the results show that there is a distinctive WISC-R profile associated with strength in the Reading Vocabulary subtest of the CAT. That profile is characterized by high scores ranking from Object Assembly and Picture Arrangement to Picture Completion to Comprehension, Vocabulary, and Similarities. Low scores rank, low to high, from Arithmetic and Digit Span to Coding and Information. The Block Design score is markedly depressed relative to Picture Arrangement and Object Assembly. This profile is remarkably consistent across the four CAT subtests discussed.

The weak groups are less homogeneous overall but are not without a pattern. The Performance scores show greater homogeneity than do the Verbal scores. The Performance profile tends to be characterized by Block Design scores that are similar to the high Object Assembly scores, and in none of the four profiles does Block Design mark the bottom of a deep trough between Picture Arrangement and Object Assembly, as it does in every case on the strong receptive language profile. Also absent from the weak profile is the valley between Similarities and Vocabulary with Arithmetic at its base that is characteristic of all the strong CAT profiles. In the weak visual receptive language profile, Arithmetic tends to be a higher or median score on the Verbal profile of the WISC-R.

Multiple analysis of variance including field dependence and sex also yields significant differences between the CAT divisions in main effects. The results differ somewhat from those obtained through one-way analysis of variance. Those cases which did not have GEFT scores were excluded from the multivariate analyses because of incomplete data. Anova tables describing those differences for the tests which form the language group are presented as Tables 6-21 through 6-29.

TABLE 6-21

GROUPS: READING VOCABULARY, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: ARITHMETIC

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	70.542	6	11.757	2.385	0.031
Read Voc	35.024	2	17.512	3.552	0.031
Field Dep	17.395	3	5.798	1.176	0.320
Sex	15.614	1	15.614	3.167	0.077
2-way Interactions	79.315	11	7.210	1.463	0.150
Read Voc-Field Dep	39.586	6	6.598	1.338	0.243
Read Voc-Sex	23.238	2	11.619	2.357	0.098
Field Dep-Sex	22.080	3	7.360	1.493	0.218
3-way Interactions	2.559	2	1.280	0.260	0.772
Read Voc-Field Dep-Sex	2.559	2	1.280	0.260	0.772
Explained	152.416	19	8.022	1.627	0.055
Residual	828.243	168	4.930		
Total	980.660	187	5.244		

TABLE 6-22

GROUPS: READING VOCABULARY, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: VOCABULARY

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	54.096	6	9.016	2.461	0.026
Read Voc	43.548	2	21.774	5.943	0.003
Field Dep	5.062	3	1.687	0.461	0.710
Sex	0.368	1	0.368	0.100	0.752
2-way Interactions	17.718	11	1.611	0.440	0.936
Read Voc-Field Dep	15.660	6	2.610	0.712	0.640
Read Voc-Sex	2.761	2	1.381	0.377	0.687
Field Dep-Sex	2.244	3	0.748	0.204	0.893
3-way Interactions	2.986	2	1.493	0.407	0.666
Read Voc-Field Dep-Sex	2.986	2	1.493	0.407	0.666
Explained	74.800	19	3.937	1.074	0.381
Residual	615.556	168	3.664		
Total	690.356	187	3.692		

TABLE 6-23

GROUPS: READING VOCABULARY, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: COMPREHENSION

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	56.459	6	9.410	2.262	0.040
Read Voc	28.566	2	14.283	3.433	0.035
Field Dep	19.498	3	6.499	1.562	0.200
Sex	2.176	1	2.176	0.523	0.471
2-way Interactions	20.842	11	1.895	0.455	0.928
Read Voc-Field Dep	13.087	6	2.181	0.524	0.789
Read Voc-Sex	1.183	2	0.592	0.142	0.868
Field Dep-Sex	1.170	3	0.390	0.094	0.963
3-way Interactions	0.874	2	0.437	0.105	0.900
Read Voc-Field Dep-Sex	0.874	2	0.437	0.105	0.900
Explained	78.174	19	4.114	0.989	0.476
Residual	698.905	168	4.160		
Total	777.080	187	4.156		

TABLE 6-24

GROUPS: READING VOCABULARY, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: DIGIT SPAN

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	76.236	6	12.706	2.398	0.030
Read Voc	41.480	2	20.740	3.914	0.022
Field Dep	35.829	3	11.943	2.254	0.084
Sex	14.663	1	14.663	2.767	0.098
2-way Interactions	59.648	11	5.423	1.023	0.428
Read Voc-Field Dep	26.294	6	4.382	0.827	0.551
Read Voc-Sex	3.680	2	1.840	0.347	0.707
Field Dep-Sex	24.387	170	8.129	1.534	0.208
3-way Interactions	11.334	2	5.667	1.069	0.346
Read Voc-Field Dep-Sex	11.334	2	5.667	1.069	0.346
Explained	147.219	19	7.748	1.462	0.105
Residual	890.334	168	5.300		
Total	1037.553	187	5.548		

TABLE 6-25

GROUPS: READING VOCABULARY, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: PICTURE ARRANGEMENT

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	122.967	6	20.495	3.545	0.002
Read Voc	67.418	2	33.709	5.830	0.004
Field Dep	35.387	3	11.796	2.040	0.110
Sex	1.740	1	1.740	0.301	0.584
2-way Interactions	116.952	11	10.632	1.839	0.051
Read Voc-Field Dep	70.177	6	11.696	2.023	0.065
Read Voc-Sex	15.678	2	7.839	1.356	0.261
Field Dep-Sex	15.849	3	5.283	0.914	0.436
3-way Interactions	74.223	2	37.112	6.419	0.002
Read Voc-Field Dep-Sex	74.223	2	37.112	6.419	0.002
Explained	314.143	19	16.534	2.860	0.000
Residual	971.325	168	5.782		
Total	1285.468	187	6.874		

TABLE 6-26

GROUPS: READING VOCABULARY, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: OBJECT ASSEMBLY

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	449.689	6	74.948	13.350	0.000
Read Voc	67.246	2	33.623	5.989	0.003
Field Dep	263.784	3	87.928	15.661	0.000
Sex	35.386	1	35.486	6.321	0.013
2-way Interactions	74.786	11	6.799	1.211	0.283
Read Voc-Field Dep	31.878	6	5.313	0.946	0.463
Read Voc-Sex	43.522	2	21.761	3.876	0.023
Field Dep-Sex	14.890	3	4.963	0.884	0.451
3-way Interactions	0.426	2	0.213	0.038	0.963
Read Voc-Field Dep-Sex	0.426	2	0.213	0.038	0.963
Explained	524.902	19	27.635	4.921	0.000
Residual	943.199	168	5.614		
Total	1468.101	187	7.851		

TABLE 6-27

GROUPS: READING COMPREHENSION, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: ARITHMETIC

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	99.921	6	16.654	3.352	0.004
Read Comp	64.404	2	32.202	6.482	0.002
Field Dep	16.556	3	5.519	1.111	0.346
Sex	6.394	1	6.394	1.287	0.258
2-way Interactions	43.159	11	3.924	0.790	0.650
Read Comp-Field Dep	12.785	6	2.131	0.429	0.859
Read Comp-Sex	7.614	2	3.807	0.766	0.466
Field Dep-Sex	10.956	3	3.652	0.735	0.532
3-way Interactions	7.986	3	2.662	0.536	0.658
Read Comp-Field Dep-Sex	7.986	3	2.662	0.536	0.658
Explained	151.066	20	7.553	1.521	0.080
Residual	829.905	167	4.968		
Total	980.660	187	5.244		

TABLE 6-28

GROUPS: LANGUAGE EXPRESSION, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: DIGIT SPAN

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	82.438	6	13.740	2.646	0.018
Lang Exp	47.682	2	23.841	4.592	0.011
Field Dep	21.552	3	7.184	1.384	0.250
Sex	29.471	1	29.471	5.676	0.018
2-way Interactions	79.451	11	7.223	1.391	0.181
Lang Exp-Field Dep	44.347	6	7.391	1.424	0.208
Lang Exp-Sex	22.504	2	11.252	2.167	0.118
Field Dep-Sex	15.624	3	5.208	1.003	0.393
3-way Interactions	8.582	2	2.861	0.551	0.548
Lang Exp-Field Dep-Sex	8.582	2	2.861	0.551	0.548
Explained	170.472	20	8.524	1.642	0.048
Residual	867.081	167	5.192		
Total	1037.553	187	5.548		

TABLE 6-29

GROUPS: LANGUAGE EXPRESSION, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: PICTURE ARRANGEMENT

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	103.482	6	17.247	2.730	0.015
Lang Exp	47.934	2	23.967	3.794	0.024
Field Dep	38.746	3	12.915	2.045	0.110
Sex	10.747	1	10.747	1.701	0.194
2-way Interactions	52.390	11	4.763	0.754	0.685
Lang Exp-Field Dep	38.066	6	6.344	1.004	0.424
Lang Exp-Sex	13.888	2	6.944	1.099	0.336
Field Dep-Sex	16.353	3	5.451	0.863	0.462
3-way Interactions	74.662	2	24.887	3.940	0.010
Lang Exp-Field Dep-Sex	74.662	2	24.887	3.940	0.010
Explained	230.535	20	11.527	1.825	0.022
Residual	1054.933	167	6.317		
Total	1285.468	187	6.874		

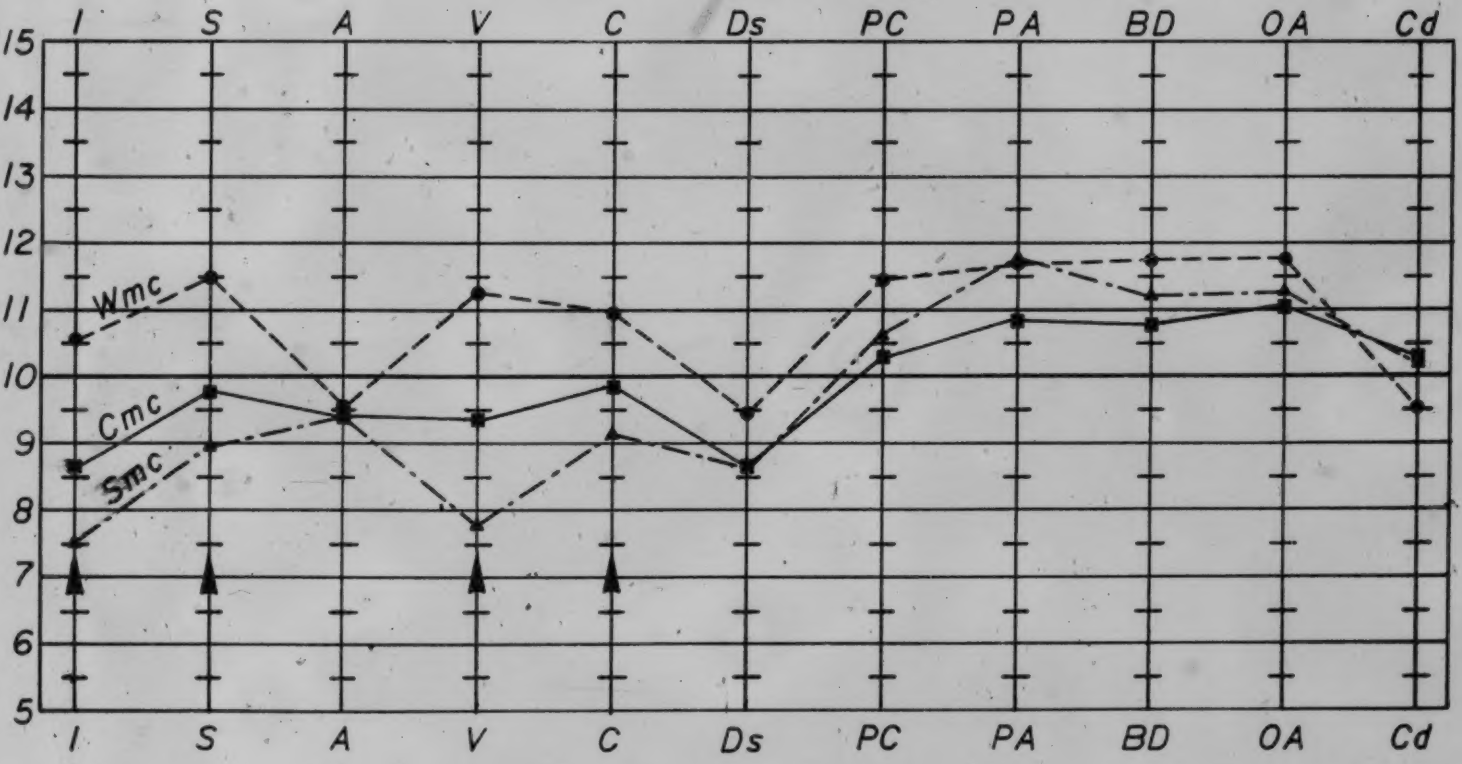
RESULTS - CAT SUBTESTS BASED ON MATHEMATICAL ABILITY

Division of the Mathematics Computation subtest into strong (Smc) and weak (Wmc) groups results in two profiles that are significantly different at the $p \leq 0.05$ level. Significant differences between the strong and weak groups occur on the following WISC-R subtests: Information - overall difference p=0.000 (difference both Wmc-Smc and Wmc-Cmc $p \leq 0.01$); Similarities - overall difference p=0.001 (difference Wmc-Smc and Wmc-Cmc $p \leq 0.01$); Vocabulary - overall difference p=0.000 (difference Cmc-Smc, Wmc-Smc, and Wmc-Cmc $p \leq 0.01$); Comprehension - overall difference p=0.013 (difference Wmc-Smc $p \leq 0.05$). There are no significant differences between the scaled score means of the Performance Scale. Anova results are presented as Tables 6-31 through 6-34. Figure 6-6 graphs the WISC-R profiles and Table 6-30 lists the WISC-R scores.

The Full Scale IQ scores for the three groups are Wmc 106.38, Cmc 99.42, and Smc 97.71. The difference between the three scores is significant (p=0.000), and the differences between Wmc and Cmc, and between Wmc and Smc are significant at $p \leq 0.05$ (see Table 6-35). The Verbal IQs, Wmc 104.24, Cmc 95.91, and Smc 90.81, are also significantly different (p=0.000) as reported in Table 6-36. Cmc and Smc, Wmc and Smc, and Wmc and Cmc are all significantly

FIGURE 6-6

WISC-R PROFILE: MATHEMATICS COMPUTATION



▲ = Difference significant at $p \leq 0.05$

TABLE 6-30

MATHEMATICS COMPUTATION CAT DIVISION WISC-R PROFILE

WISC-R IQ SCALE	WEAK MC SCORE (SD) (N = 21)	MID MC SCORE (SD) (N = 174)	STRONG MC SCORE (SD) (N = 21)
Full Scale	106.38 (8.81)	99.42 (8.13)	97.71 (8.73)
Verbal	104.24 (8.36)	95.91 (8.70)	90.81 (8.50)
Performance	108.14 (13.33)	104.02 (10.64)	106.71 (12.01)

WISC-R SUBTEST	WEAK MC SCORE (SD)	MID MC SCORE (SD)	STRONG MC SCORE (SD)
VERBAL			
Information	10.57 (1.99)	8.64 (2.05)	7.52 (2.04)
Similarities	11.48 (2.80)	9.79 (2.29)	8.90 (1.64)
Arithmetic	9.57 (2.23)	9.35 (2.23)	9.38 (2.29)
Vocabulary	11.24 (1.22)	9.32 (1.81)	7.81 (1.69)
Comprehension	10.90 (2.19)	9.83 (1.94)	9.14 (1.85)
Digit Span	9.43 (2.71)	8.68 (2.35)	8.57 (2.25)
PERFORMANCE			
Picture Comp.	11.43 (2.69)	10.28 (2.50)	10.57 (2.11)
Picture Arr.	11.67 (2.63)	10.85 (2.49)	11.81 (3.25)
Block Design	11.71 (2.72)	10.78 (2.74)	11.19 (2.40)
Object Assem.	11.76 (2.66)	11.05 (2.87)	11.29 (2.51)
Coding	9.52	10.30	10.19

TABLE 6-31

CAT GROUPS DIVIDED BY MATHEMATICS COMPUTATION; WISC-R VARIABLE: INFORMATION

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	103.004	51.522	12.300	.0000
Within Groups	213	892.289	4.189		
Total	215	995.333			

TABLE 6-32

CAT GROUPS DIVIDED BY MATHEMATICS COMPUTATION; WISC-R VARIABLE: SIMILARITIES

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	74.771	37.386	7.113	.0010
Within Groups	213	1119.600	5.256		
Total	215	1194.370			

TABLE 6-33

CAT GROUPS DIVIDED BY MATHEMATICS COMPUTATION; WISC-R VARIABLE: VOCABULARY

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	124.888	62.444	20.442	.0000
Within Groups	213	650.663	3.055		
Total	215	775.551			

TABLE 6-34

CAT GROUPS DIVIDED BY MATHEMATICS COMPUTATION; WISC-R VARIABLE: COMPREHENSION

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	33.898	16.949	4.439	.0129
Within Groups	213	813.209	3.818		
Total	215	847.107			

TABLE 6-35

CAT GROUPS DIVIDED BY MATHEMATICS COMPUTATION; WISC-R VARIABLE: FULL SCALE IQ

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	1022.347	511.173	7.489	.0007
Within Groups	213	14539.612	68.261		
Total	215	15561.958			

TABLE 6-36

CAT GROUPS DIVIDED BY MATHEMATICS COMPUTATION; WISC-R VARIABLE: VERBAL IQ

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	1981.130	990.565	13.142	.0000
Within Groups	213	16054.755	75.374		
Total	215	18036.884			

different at the 95 percent level of confidence. The Performance IQs, however, do not differ significantly. The discrepancy between Performance and Verbal IQ for Smc is the greatest discrepancy found in the study within either a strong or weak group. The Verbal IQ for Smc is 90.81; the Performance IQ is 106.71. The 15.9-point difference is significant at $p<0.01$ by *t* test.

RESULTS - CAT SUBTESTS BASED ON MATHEMATICS AND LANGUAGE ABILITIES

In the CAT battery, only the Mathematics Concepts and Applications subtest demands both mathematical and visual receptive language skills. In contrast to the Mathematics Computation subtest in which all the questions are presented as numerical problems or equations, the Mathematics Concepts and Applications subtest begins each problem with a question which requires reading comprehension skills. The subtest also includes a number of written or word problems. It was anticipated that the Mathematics Concepts and Applications subtest would show significant differences if a profile characteristic of learning disability in both mathematics or numerical ability *and* language ability were manifested. There are no significant differences between the strong and weak groups at the 95 percent level of confidence. Two subtests, however, appproach that level. There is an overall difference between Smca, Cmca, and Wmca significant at $p=0.062$ on the Arithmetic subtest. The Smca group scored high at 10.43, with Cmca followed by Wmca scoring 9.29 and 9.00 respectively. The Coding subtest differences are significant at p=0.07, but in this case the Smca group scores lower than the Wmca group (9.05 to 10.10). Anova tables are not included for those differences which do not attain the $\underline{p} \leq 0.05$ level of significance.

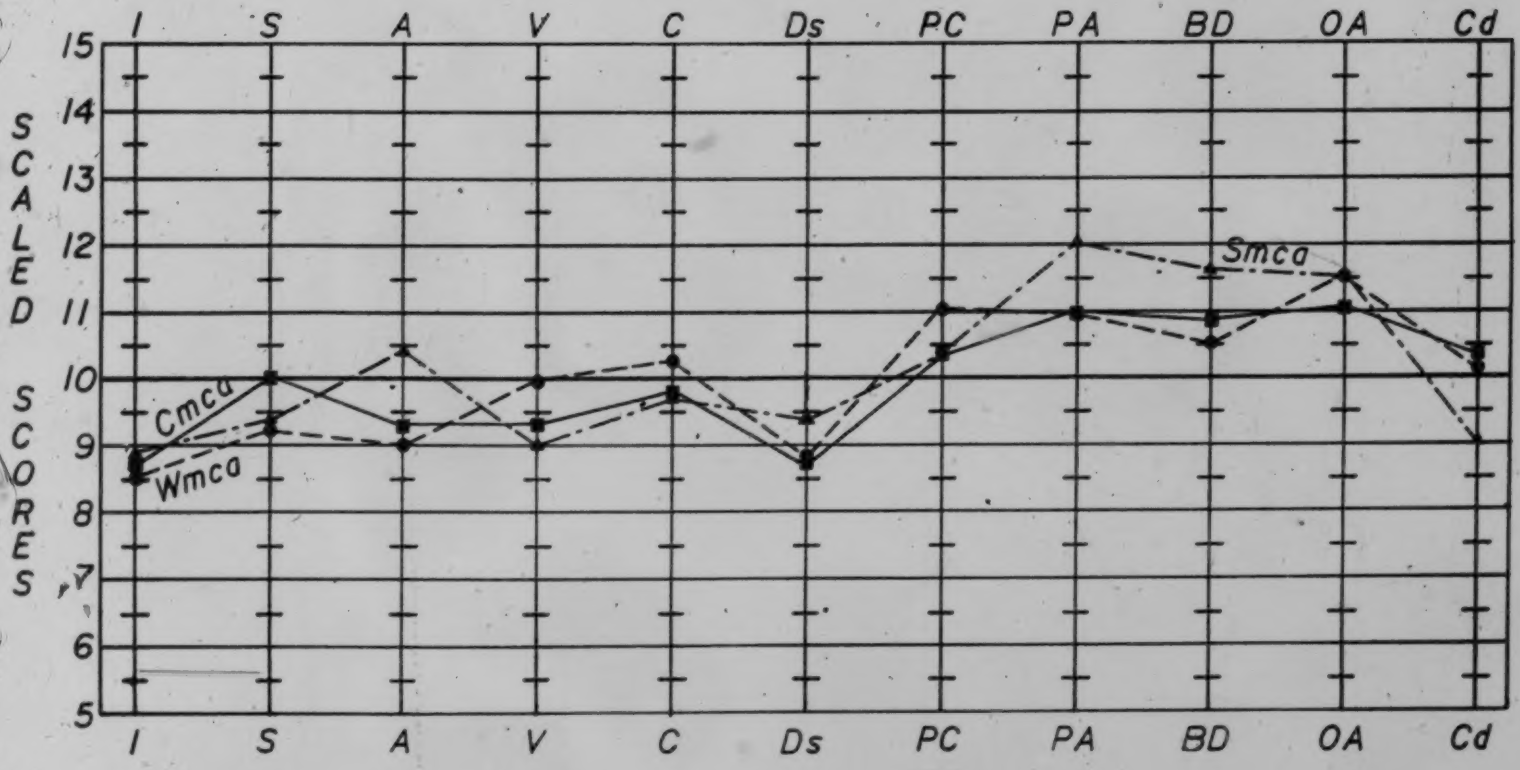
In a rough way the Verbal profile of the Smca fits the pattern of peaks and valleys of the Smc group with the elevations leveled somewhat on the former (see Figure 6-7 and Table 6-37). The Performance profile of the Smca group fits the Smc pattern perhaps even better except that the Coding score is lower for the former group. The Wmca profile corresponds to the Cmca or total group profile as closely as it does to any of the others, and a case cannot be made from this data for a profile characteristic of both mathematics and language disability.

RESULTS - CAT SPELLING SUBTEST

A distinctive profile cannot be claimed for spelling strength or weakness on the basis of significant differences between three or more of the WISC-R subtests; only two of the subtests, Similarities (p=0.010) and Block Design (p=0.043), differ at the level of significance prescribed as shown in Tables 6-38 and 6-39. The Spelling division, however, also yields significant differences in relation to

FIGURE 6-7

WISC-R PROFILE: MATHEMATICS CONCEPTS & APPLICATIONS



▲ = Difference significant at $p \leq 0.05$

TABLE 6-37

MATH. CONCEPTS & APPLICATION CAT DIVISION WISC-R PROFILE

WISC-R IQ SCALE	WEAK MCA SCORE (SD) (N = 21)	MID MCA SCORE (SD) (N = 174)	STRONG MCA SCORE (SD) (N = 21)
Full Scale	99.86 (8.44)	99.83 (8.38)	100.86 (9.92)
Verbal	95.76 (8.71)	96.27 (9.33)	96.33 (8.56)
Performance	105.19 (13.61)	104.42 (10.48)	106.38 (13.40)
WISC-R SUBTEST	WEAK MCA SCORE (SD)	MID MCA SCORE (SD)	STRONG MCA SCORE (SD)
VERBAL			
Information	8.52 (1.75)	8.73 (2.23)	8.86 (1.88)
Similarities	9.19 (2.40)	10.01 (2.40)	9.38 (1.80)
Arithmetic	9.00 (1.90)	9.29 (2.23)	10.43 (2.29)
Vocabulary	9.90 (2.10)	9.33 (1.87)	9.00 (1.95)
Comprehension	10.24 (1.55)	9.84 (2.00)	9.71 (2.31)
Digit Span	8.83 (2.40)	8.71 (2.30)	9.38 (2.99)
PERFORMANCE			
Picture Comp.	11.05 (3.35)	10.34 (2.36)	10.43 (2.68)
Picture Arr.	10.90 (2.74)	10.91 (2.45)	12.05 (3.67)
Block Design	10.52 (3.23)	10.86 (2.64)	11.67 (2.73)
Object Assem.	11.52 (3.34)	11.05 (2.65)	11.52 (3.59)
Coding	10.10 (2.30)	10.37 (2.55)	9.05 (1.99)

TABLE 6-38

CAT GROUPS DIVIDED BY SPELLING; WISC-R
VARIABLE: SIMILARITIES

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	50.322	25.161	4.685	.0102
Within Groups	213	114.048	5.371		
Total	215	1194.370			

TABLE 6-39

CAT GROUPS DIVIDED BY SPELLING; WISC-R
VARIABLE: BLOCK DESIGN

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	46.073	23.036	3.199	.0428
Within Groups	213	1534.076	7.202		
Total	215	1580.148			

TABLE 6-40

CAT GROUPS DIVIDED BY SPELLING;
VARIABLE: FIELD DEPENDENCE

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	11.984	5.992	4.480	.0124
Within Groups	213	284.887	1.338		
Total	215	296.870			

Group Embedded Figures Test scores. Wsp and Ssp GEFT score differences are significant, by t test at $p<0.005$, and the overall difference between the three groups is significant at $p=0.0124$ as demonstrated in Table 6-40. It is the weaker spelling group which receives the higher Similarities and Block Design scores, and the weaker group is the more field independent group. The GEFT score mean for Wsp is 11.06 (this score is at the boundary between the third and fourth quartiles of field dependence for the research group) as compared to 6.42 (approximately the mid-second quartile) for Ssp.

The Full Scale IQ scores for Ssp, Csp, and Wsp are, in the same order, 96.48, 99.81, 104.38. These scores differ significantly ($p=0.009$). The difference between Ssp and Wsp FSIQ is significant at $p<0.05$ as is the difference between the pair on Verbal IQ. The VIQ for Ssp is 93.81 and for Wsp it is 100.38. Overall differences in Verbal IQ are significant at the $p=0.0258$ level. Anova tables for the IQ scores are presented as Tables 6-41 and 6-42. The differences in Performance IQ are not significant for this CAT Spelling division, and the PIQ-VIQ differences are virtually the same as those of the total research group: Total Group 8.46, Wsp 8.38, Csp 8.43, Ssp 8.71. The Spelling profile and its accompanying data table are inserted as Figure 6-8 and Table 43, respectively.

TABLE 6-41

CAT GROUPS DIVIDED BY SPELLING; WISC-R VARIABLE: FULL SCALE IQ

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	669.027	334.513	4.784	.0093
Within Groups	213	14892.932	69.920		
Total	215	15561.958			

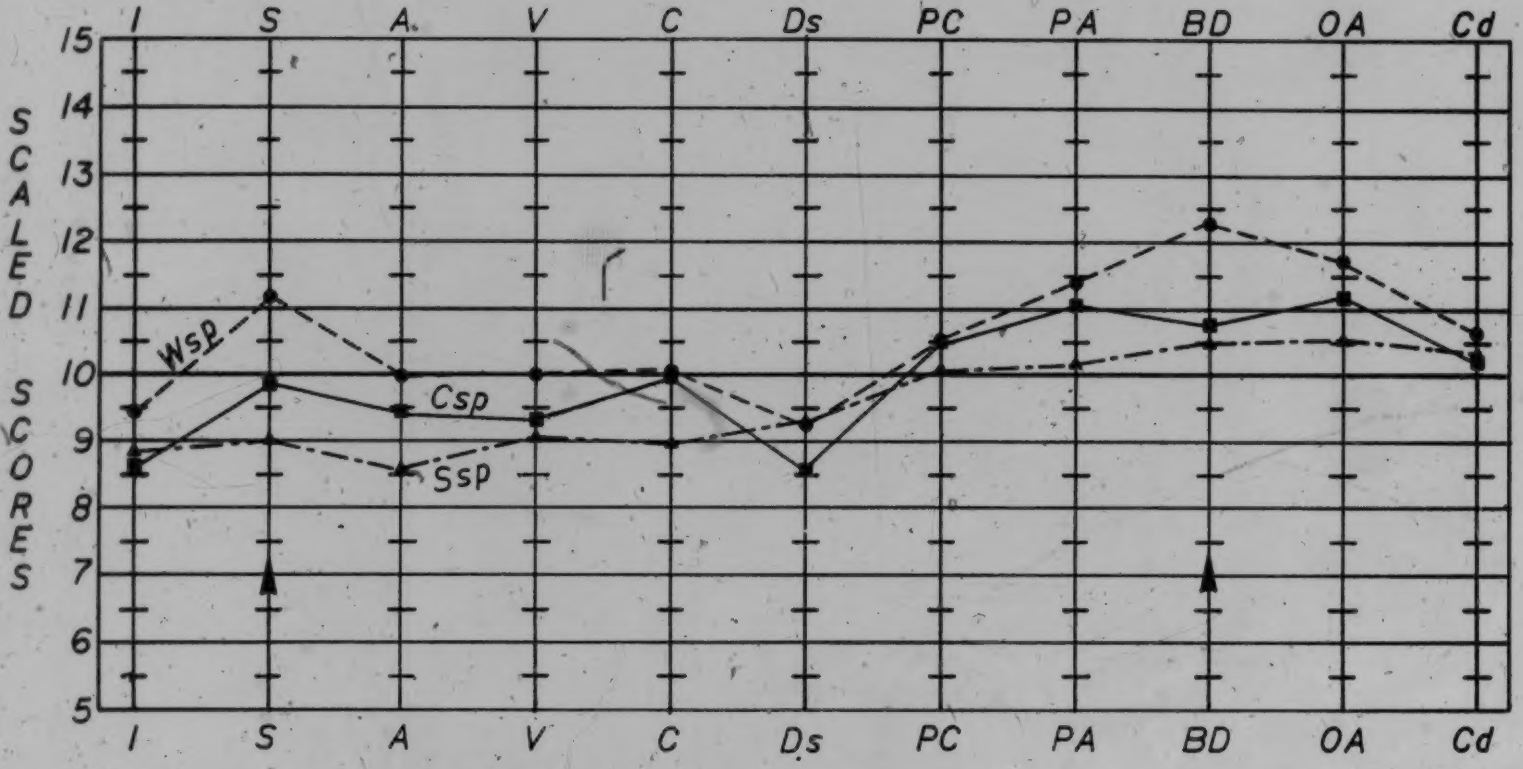
TABLE 6-42

CAT GROUPS DIVIDED BY SPELLING; WISC-R VARIABLE: VERBAL IQ

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	2	609.004	304.502	3.722	.0258
Within Groups	213	17426.880	81.816		
Total	215	18035.884			

FIGURE 6-8

WISC-R PROFILE: SPELLING



▲ = Difference significant at $p \leq 0.05$

TABLE 6-43

SPELLING CAT DIVISION WISC-R PROFILE

WISC-R IQ SCALE	WEAK SP SCORE (SD) (N = 21)	MID SP SCORE (SD) (N = 174)	STRONG SP SCORE (SD) (N = 21)
Full Scale	104.38 (9.65)	99.81 (8.34)	96.48 (6.97)
Verbal	100.38 (10.76)	96.14 (8.84)	92.81 (8.97)
Performance	108.76 (13.61)	105.58 (10.48)	101.52 (13.40)

WISC-R SUBTEST	WEAK SP SCORE (SD)	MID SP SCORE (SD)	STRONG SP SCORE (SD)
VERBAL			
Information	9.43 (2.75)	8.62 (2.05)	8.86 (2.26)
Similarities	11.14 (2.85)	9.82 (2.26)	9.00 (2.24)
Arithmetic	9.95 (2.69)	9.40 (2.22)	8.57 (1.50)
Vocabulary	10.00 (1.82)	9.32 (1.88)	9.04 (2.09)
Comprehension	10.05 (1.94)	9.95 (2.01)	8.95 (1.69)
Digit Span	9.24 (2.63)	8.61 (2.33)	9.29 (2.49)
PERFORMANCE			
Picture Comp.	10.52 (2.36)	10.45 (2.58)	10.05 (1.91)
Picture Arr.	11.38 (2.06)	11.09 (2.65)	10.10 (2.84)
Block Design	12.29 (2.92)	10.79 (2.67)	10.48 (2.58)
Object Assem.	11.71 (2.49)	11.14 (2.88)	10.52 (2.52)
Coding	10.62 (2.54)	10.15 (2.50)	10.33 (2.48)

RESULTS - CAT LANGUAGE MECHANICS SUBTEST

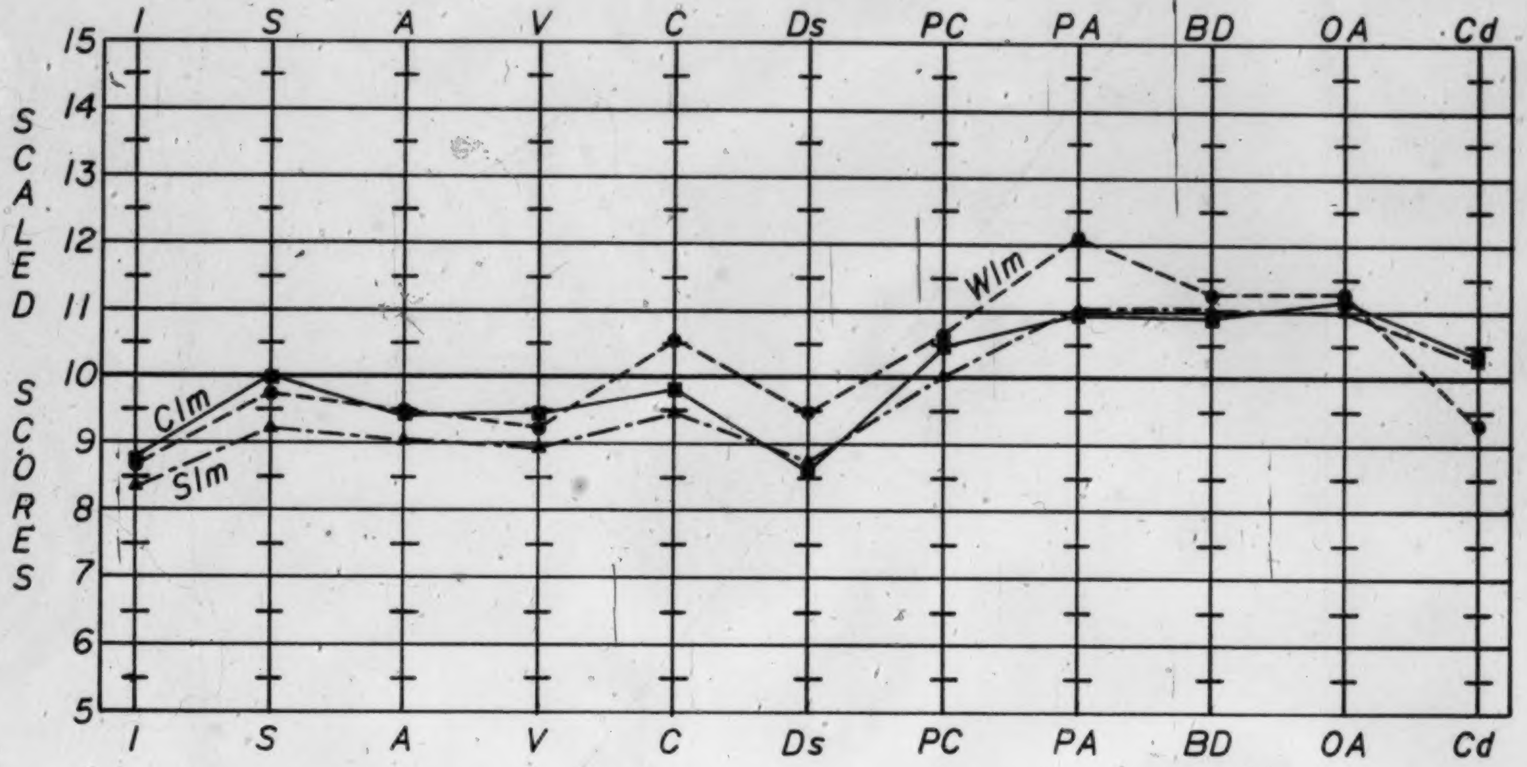
Division of this CAT subtest into strong and weak groups yields no significant differences in IQ scores, subtest scores, or field independence scores. Like Spelling, the Performance IQ-Verbal IQ differences manifest are very similar to those shown by the total research group, i.e., the differences range from 8.31 to 9.86. The graphed profiles, which follow as Figure 6-9 (supporting data in Table 6-44), for the strong and weak groups resemble the comparison group within the Language Mechanics division as much as they do any other profiles in the study. These results are of interest because the WISC-R scores show so little difference between the top and bottom ten percent in Language Mechanics achievement.

DISCUSSION - CAT SUBTESTS BASED ON VISUAL LANGUAGE RECEPTION

On the Verbal subtests, WISC-R profiles corresponding to strength in visual language reception language show, in general, their highest scores on Similarities, Vocabulary, and Comprehension. This triad corresponds to Bannatyne's Verbal Conceptualization triad. It also corresponds to those WISC-R subtests identified as measuring ability in verbal expression. The Performance profile has high scores in Picture Arrangement and Object Assembly with good

FIGURE 6-9

WISC-R PROFILE: LANGUAGE MECHANICS



▲ = Difference significant at $p \leq 0.05$

TABLE 6-44
LANGUAGE MECHANICS CAT DIVISION WISC-R PROFILE

WISC-R IQ SCALE	WEAK LM SCORE (SD) (N = 21)	MID LM SCORE (SD) (N =181)	STRONG LM SCORE (SD) (N = 14)
Full Scale	100.52 (8.69)	100.05 (8.57)	97.50 (7.50)
Verbal	96.67 (11.91)	96.39 (9.05)	93.43 (5.02)
Performance	105.52 (8.93)	104.70 (11.28)	103.29 (12.04)

WISC-R SUBTEST	WEAK LM SCORE (SD)	MID LM SCORE (SD)	STRONG LM SCORE (SD)
VERBAL			
Information	8.62 (2.91)	8.76 (2.09)	8.36 (1.74)
Similarities	9.71 (3.18)	9.94 (2.31)	9.21 (1.37)
Arithmetic	9.48 (2.32)	9.39 (2.27)	9.07 (1.44)
Vocabulary	9.19 (2.04)	9.41 (1.91)	8.93 (1.64)
Comprehension	10.52 (2.14)	9.82 (2.00)	9.43 (1.40)
Digit Span	9.48 (3.17)	8.65 (2.31)	8.79 (1.81)
PERFORMANCE			
Picture Comp.	10.62 (2.27)	10.43 (2.53)	10.00 (2.54)
Picture Arr.	12.10 (3.02)	10.90 (2.63)	11.07 (1.44)
Block Design	11.24 (1.87)	10.86 (2.77)	11.00 (3.14)
Object Assem.	11.29 (2.55)	11.14 (2.83)	11.00 (3.14)
Coding	9.33 (2.69)	10.31 (2.46)	10.21 (2.58)

strength in Picture Completion. Successful performance on Picture Arrangement and Object Assembly, requires strength in the perception and organization of meaningful visual details and the ability to synthesize those details into meaningful visual wholes.

The strong visual receptive language profiles show, with one exception, their lowest WISC-R scores on the Arithmetic and Digit Span subtests. On the exception, the Reference Skills division, Information narrowly displaces Arithmetic as the second lowest subtest. Information is the third lowest score on the Verbal profile of the other three CAT divisions. On the Performance side of the profiles, the lowest score is Coding. Coding is the fourth lowest score on the total profile in three out of four cases. Here the exception is the Language Expression division. The second lowest score on three-fourths of the profiles is Block Design. On the Reference Skills division, an exception for a second time, Picture Completion falls below Block Design by 0.08 of a point. The reader will recognize the four lowest scores, Arithmetic, Coding, Information, and Digit Span, as the ACID profile. The ACID profile also contains within it the Freedom from Distractibility Factor, but of the four profiles, only the Reading Vocabulary division approaches weakness in Kaufman's Distractibility Factor or Bannatyne's Sequential triad (as distinct from the ACID profile). In all divisions, the Coding score is greater than the Digit Span, Arithmetic, and Information scores, and even though those differences are not statistically significant, it may be worthwhile to look at explanations other than the Third Factor to account for the differences in the weak and strong profiles.

The profiles of the weak visual receptive language groups are, as previously noted, less homogeneous than are the strong groups' profiles, and the greatest variability arises in the Verbal profiles. The Reading Vocabulary and Reading Comprehension divisions tend to show similar Verbal profiles. The most obvious feature of the profiles is a plateau formed between Similarities and Arithmetic sloping sharply down to Information and Vocabulary--two of the lowest scores on the two profiles--on either side. Similarities and Arithmetic require reasoning as opposed to rote memory, while Vocabulary and Information can be successfully dealt with for the most part through recall rather than reasoning. Digit Span is also low. It is greater than Vocabulary on the Srv profile but still in the lower half of the profile. The greater Digit Span score is to be expected inasmuch as that profile is selected specifically on the basis of weakness in reading vocabulary. The Digit Span mean of the Wrc group is approximately equal to the Vocabulary mean. Like Vocabulary and Information, Digit Span operates out of rote memory. The Language Expression and Reference Skill divisions show relatively flat Verbal profiles, and the Similarities-Arithmetic plateau is absent in both. This result would again reflect selection through the CAT divisions. Both the Language Expression and Reference Skill subtests require reasoning rather than simple recall. The Wle and Wrs groups are selected, at least in part, on the basis of a deficit in that skill.

The more homogeneous Wle and Wrs Performance profiles are characterized by a smooth rise from Picture Completion to Object Assembly which declines more or less sharply to Coding. The Language Expression division deviates slightly in that Picture Arrangement, Block Design, and Object Assembly vary less than 0.25 of a point to create a broad plateau on the performance side. Picture Completion and Coding are the lowest scores on the Performance profile; although, on the Reading Vocabulary division, Picture Completion is marginally lower than Coding. With these profiles, as with the Verbal profiles of the weak language group, reasoning (nonverbal) and restructuring, as reflected in the Block Design and Picture Arrangement scores, seem to take precedence over factors based primarily in memory. Further, it seems necessary to differentiate recall from recognition in this case. Visual recall (PC and Cd) is relatively weaker than visual recognition (OA).

On the basis of the analysis to this point, it seems reasonable to suggest that the strong visual receptive language profile when considered in light of the WISC-R subtests can be said to represent a strong language profile which includes both visual and verbal receptive and expressive abilities. By virtue of being in the top ten percent of Reading Vocabulary, Reading Comprehension, Language Expression, or Reference Skills, the students involved have demonstrated strength in visual receptive language processing relative to their overall abilities. Strength on Similarities, Vocabulary, and Comprehension suggests relative strength in expressive language as well. These subtests also deal with semantically meaningful material.

The Picture Arrangement subtest is also a test of semantic or "meaning-making" ability. Picture Arrangement is, as are Picture Completion and Object Assembly, composed of visually meaningful stimuli. Success on Picture Completion and Object Assembly is indicative of a high level of visual awareness and of the ability to separate essential from nonessential detail in a stimulus complex. It is indicative as well, as has been previously observed, of visual recall and recognition. These abilities are related to the ability to form visual gestalts and, perhaps of greater importance, are strongly indicative of the ability to *recognize familiar visual gestalts*. If words are considered as visual gestalts, the abilities noted would facilitate reading, and that, in fact, seems to be the case.

The tests on which this strong language group does less well, Arithmetic, Digit Span, Block Design, and Coding, are for the most part constructed from nonlinguistic and nonmeaningful stimuli. The other subtest on which this group does poorly is Information which is language based and meaningful. Information does, however, differ from the other semantically meaningful subtests on which the strong language group performs well. Information requires little in expressive language abilities and only limited receptive language skills. It requires recall, on demand, of specific items of unrelated information rather than an elaborate verbal construction. Information requires a nominative or naming function rather than development of relationships.

It may be asserted, then, that superior strength in language relative to other abilities is a factor of a facility and a predisposition to form and/or apprehend word gestalts, both graphemic and phonemic; to attend to verbally or visually meaningful stimuli; and to mediate experience by encoding it semantically whenever possible. And as a corollary, if language is primarily processed sequentially as is asserted, it includes the predisposition to process information sequentially or successively. Because Similarities is thought to be processed simultaneously, relatively strong scores on the subtest among the strong language group detract somewhat from this conceptualization. An alternative explanation of how Similarities may be processed merits examination.

The Similarities subtest is thought to be processed simultaneously (Das, Kirby, & Jarman, 1975). However, it is acknowledged that different groups (age groups, socio-economic groups, ethnic groups) as well as different individuals may process the same stimuli differently (Das, 1973). It might, then, be argued that although this group processes the other subtests successively, it processes this one simultaneously. There may be an alternative answer. The mean score on Similarities for the four CAT groups Wrv, Wrc, Wle, and Wrs is 10.23. To have achieved that scaled score, the group would have had to obtained full points on the first eleven items of the subtest. The entities to be compared in those first eleven items are very familiar, and may be processed primarily through rote memory of their class membership. If such is the case, then it is probable that a successive synthesis based primarily on association is at work here as well, and the argument for a predisposition to process sequentially can be preserved.

It is clear, however, that the key element is meaningful visual or verbal stimuli rather than sequential processing alone. The strong language group obtains its lowest scores on those subtests which are not visually or verbally meaningful but which must be processed sequentially. While the Arithmetic subtest demands some ability with language, and the problem senarios are meaningful, skill in arithmetic is primary. Neither Digit Span nor Coding offer meaningful material, and both demand sequential or successive processing for success. Concommitantly, both require operation of short-term memory. Block Design is nonmeaningful and abstract, and it ordinarily requires simultaneous processing; however, Kaufman notes that both Block Design and Coding are different from the other Performance tests in that while the other tests are problem-solving tests, Block Design and Coding are essentially copying tasks (1979, p. 165). As a copying task Block Design may demand sequential rather than simultaneous synthesis. It may well be that it is an inappropriate approach to the task that yields the low scores obtained by the strong language group on the Block Design subtest.

In summary, exceptional strength in language processing may be recognized on the WISC-R by a profile which shows high scores on the verbal tests which require sequential processing of meaningful data, specifically the tests associated with verbal expression (Similarities, Vocabulary, and Comprehension) accompanied by high scores on those Performance subtests which have meaningful visual stimulus material (Picture Completion, Picture Arrangement, and Object Assembly). Those subtests which contain stimulus material that is not inherently meaningful (Arithmetic, Digit Span, Block Design, and Coding) will be low relative to individual means. Information will also be weak. Individuals in this group will show good verbal language expression and good reading comprehension, but may have difficulty with tasks that require reasoning rather than recall. It seems probable that they will show deficit performance on tasks which demand recall and organization of specific detail as opposed to tasks requiring broad conceptualization, and they will not do well with abstract material, especially nonverbal material.

The weak language groups are more difficult to characterize. The Reading tests, Reading Vocabulary and Reading Comprehension, select those whose specific weakness is general comprehension of reading material and/or limitation of reading vocabulary. The tasks of the CAT subtests demand, primarily, interpretation of the graphemes; association of words with opposite or similar meaning; and literal, interpretive, and critical comprehension: all tasks of language reception. Students selected as weak by these subtests may have other language skills within the context of the classroom and elsewhere. Those selected as weak by the Language Expression and Reference Skills subtests are likely to demonstrate a greater overall deficit, for these subtests require more than reception: they require expression and application.

The primary qualities which the Reading subtests do not select against appear to be reasoning and problem solving. Language Expression and Reference Skills apparently demand most of the language skills examined on the WISC-R, and the Verbal profiles are relatively flat compared to those of the Reading profiles. The Wrv and Wrc profiles manifest relative strength in reasoning and problem solving through high scores on Similarities and Arithmetic on the Verbal profile and through generally higher scores on the Performance profile, including Block Design. Block Design approaches the same level as Object Assembly on all four of the weak language profiles which is contrary to the strong language profile where it competes with Coding for the low Performance score. The weak language groups are better able to deal with nonverbal and nonmeaningful information than are their strong counterparts. Visual memory appears to be deficient as the Picture Completion and Coding scores are low relative to the other Performance scores on all four of the weak language profiles. Visual memory may be a factor in the poor reading ability of the weak visual receptive language groups.

The group of poor readers seems to share the qualities of greater facility for simultaneous as opposed to sequential or successive processing and for processing nonverbal and nonmeaningful stimuli throughout the four language tests. However, there appear to be two subgroups within the weak language group. One group tends to use reasoning in problem solving, and it is recognizable by its relatively higher scores on Arithmetic and Similarities. This group may represent those students who do poorly in Language Arts but reasonably well in mathematics and science. The second group, which manifests a relatively flat Verbal profile, is difficult to characterize. The Wle group's Performance and Verbal IQs differ by 9.15 points ($\underline{p}<0.15$) while the Wrs group manifests only a 1.55 point difference (P>V). Both Verbal IQs differ from the mean IQ of 100 by less than two points. In this context, it seems reasonable to assert that what is revealed is a specific deficit in visual receptive and expressive language skills but normal oral language ability. However, without the reading test with which to compare the WISC-R results, both these profiles would appear to be well within the normal range and would have no diagnostic value.

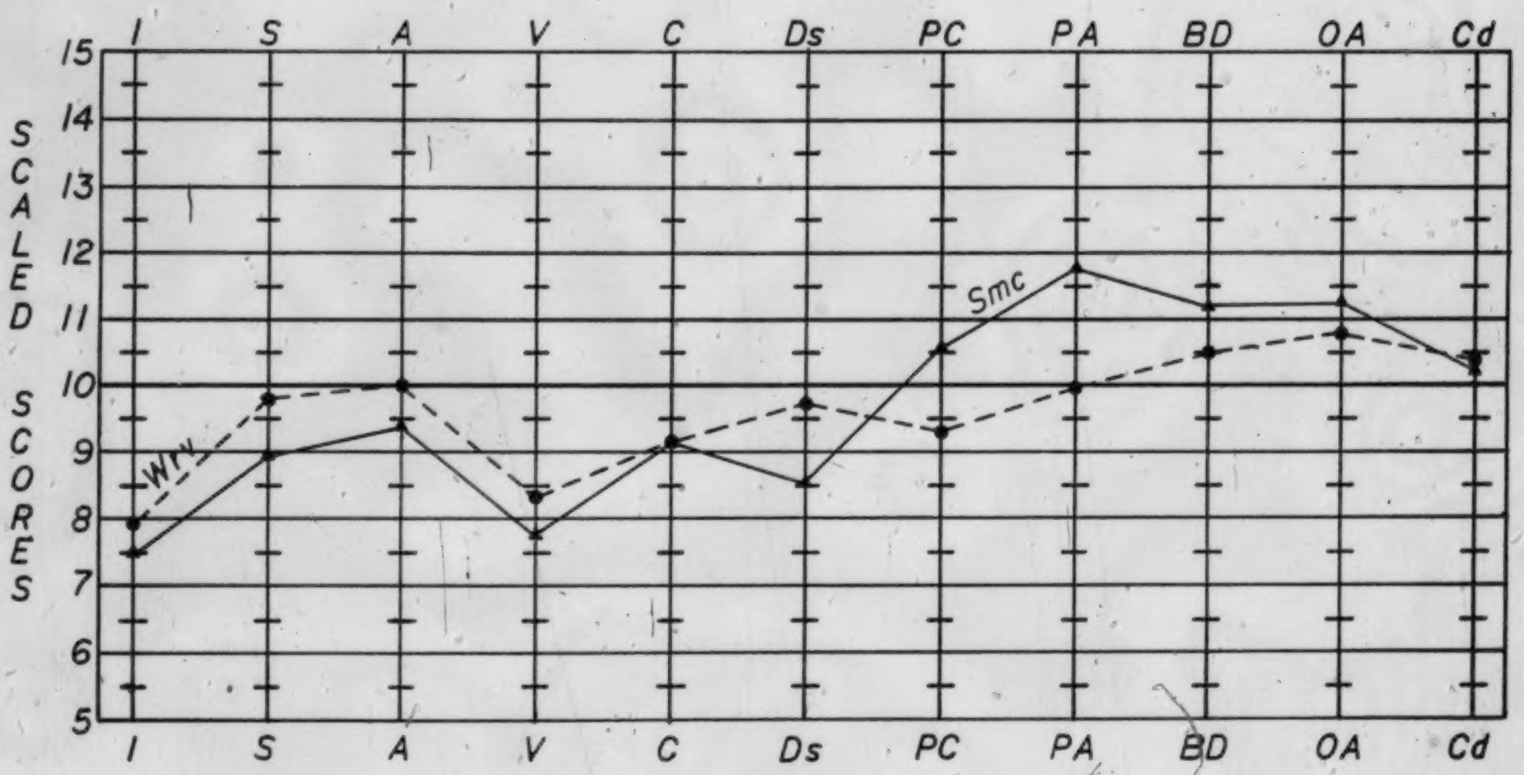
In concluding the discussion of the language based CAT tests and their WISC-R profiles, the observation is made that students showing strong language skills also show strong abilities in the sequential processing of verbal and meaningful materials but a clear deficit in processing nonverbal and nonmeaningful visual stimuli. As well, this group may have a predisposition to operate from long-term semantic memory rather than reasoning whenever possible. The weak language groups show greater ability to process a variety of stimuli: nonverbal and nonmeaningful visual materials including numbers. This may reflect a greater tendency to process simultaneously. A relative weakness in visual memory may contribute to reduced reading skill.

DISCUSSION - CAT SUBTESTS BASED ON MATHEMATICAL ABILITY

One of the most interesting results of the study is found in the comparison of the Mathematics Computation profiles with the Reading Vocabulary profiles. On the verbal side of the profiles, there are remarkable resemblences between the shapes of the strong Mathematics Computation profile and the weak Reading Vocabulary profile, and between the weak Mathematics Computation profile and the strong Reading Vocabulary. The Smc Verbal profile presents the same plateau formed by Similarities and Arithmetic rising above Information on one side and Vocabulary on the other as exhibited on the Wrv profile; and on both profiles, Comprehension and Digit Span fall at intermediate levels of the Verbal scores. The Wmc and Srv show the same low scores at Arithmetic and Digit Span with high scores on Similarities, Vocabulary, and Comprehension with Information at an intermediate level. (See Figures 6-10 and 6-11.) Wmc, Srv, and Srs are the only CAT subtest divisions on which the ACID profile appears. The weak Mathematics Computation profile is the only profile that manifests a weakness on the Freedom from Distraction Factor or Sequential Category, as distinct

FIGURE 6-10

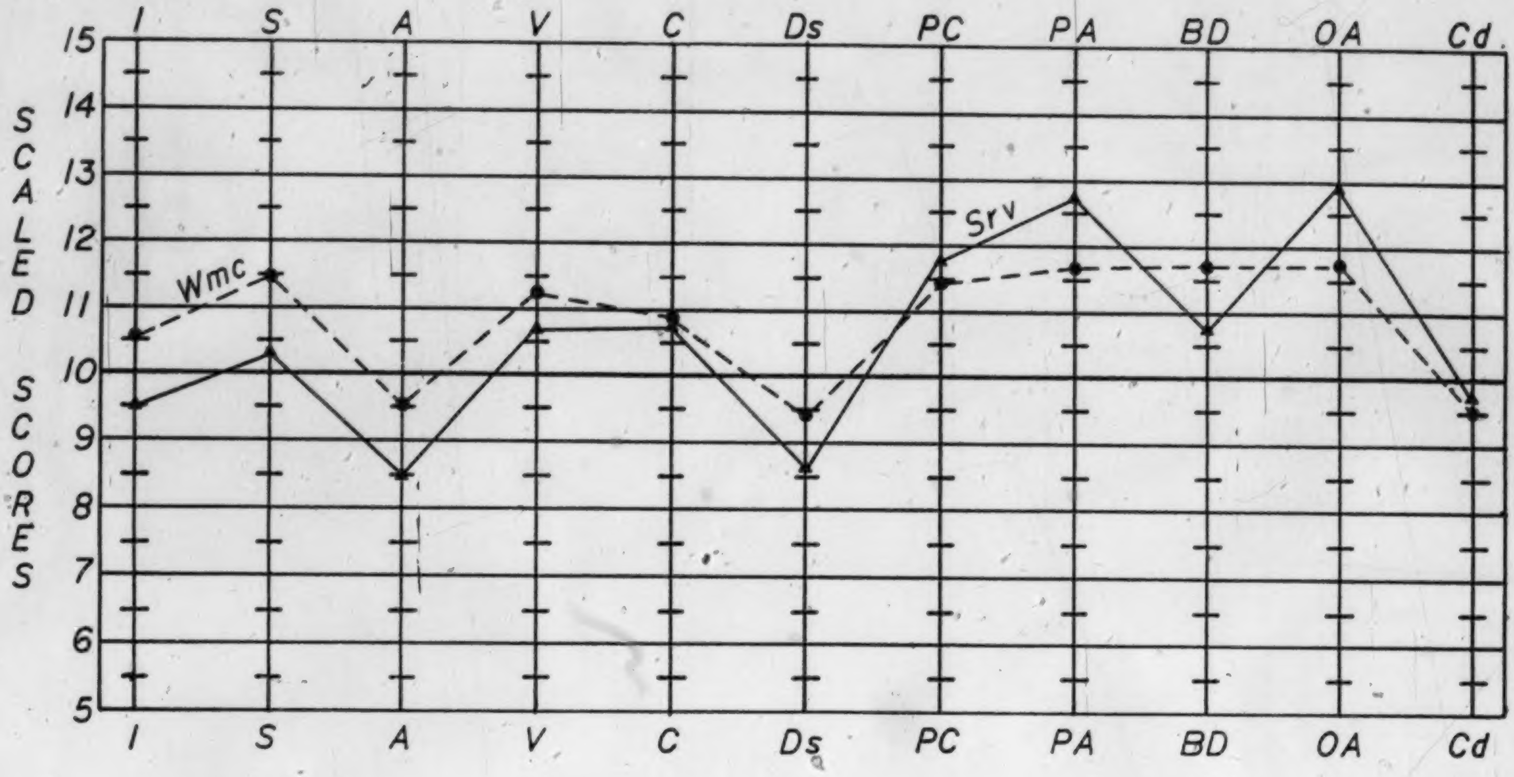
WISC-R PROFILE: STRONG MATH. COMP - WEAK READ. VOC.



▲ = Difference significant at $p \leq 0.05$

FIGURE 6-11

WISC-R PROFILE: WEAK MATH. COMP. - STRONG READ. VOC.



▲ = Difference significant at $p \leq 0.05$

from its inclusion in the ACID profile, i.e., it is the only profile on which Arithmetic, Digit Span, and Coding all fall below Information.

At first look it appears that essentially the same analysis applies here as pertained in the discussion of the language based tests. Weak mathematical ability appears to be associated with relative verbal strength, presumably the sequential processing of language, and with an inability to process nonverbal or nonlinguistic stimuli. The problem is, however, more complex. Contrary to what might be anticipated, the weak mathematics group does not show the same nonverbal reasoning deficit as do all the strong language groups; Block Design scores are comparable to Picture Completion, Picture Arrangement, and Object Assembly. While it is not clear how strength in the reading subtests selects weakness in nonverbal reasoning, a tentative explanation may rest on the argument that the unique requirement of Block Design is analysis, that is, the ability to break a whole into its elements. Exceptionally strong language skill, as differentiated, from weak math ability, may sacrifice analysis for efficiency in synthesis. Two further observations tend to corroborate this hypothesis. With regard to analysis, the Wmc group is more field independent than all the strong language groups and field independence requires breaking up a stimulus field into its elements; it demands analysis. With regard to synthesis, Picture Arrangement and Object Assembly are exceptionally strong compared to the other scores in the Srv profile. The mean score for all the other subtests is 10.12; the mean score for Picture Arrangement and Object Assembly is 12.84. The scores obtained on the Wmc profile compared in a similar manner are 10.65 for the other nine subtests and 11.71 for Picture Arrangement and Object Assembly. The difference between the PA-OA mean and the Block Design score is 2.72 for Srv; the Block Design score is equal to the PA-OA mean for Smc.

A second more specific deficit may also play a role here. All three subtests that require the manipulation of symbols, Arithmetic, Digit Span, and Coding are similar in value and are uniformly low. ['Symbols' is used here in the Structure of Intellect sense meaning "denotative signs, having no significance in and of themselves, such as letters, numbers, musical notations, codes, and words, when meanings and form are not considered (Sattler, 1982, p. 606).] For example, the scores for Arithmetic, Digit Span and Coding are, respectively, 9.57, 9.43, and 9.52, yielding a mean score of 9.51. That mean compares with a mean of 11.35 for the other WISC-R subtests.

In summary, weak mathematical ability seems to be associated with strong language skills, and concommitantly, with a tendency to mediate experience through language. The weak mathematics group seems to have high efficiency in synthesis yet retains analytical skills. Those analytical skills are manifest by Block Design scores equal in value to the other spatial scores and third quartile field independence scores. A specific symbolic--as opposed to graphemic--weakness is manifest as well.

The Verbal profile for strength in mathematics is similar to the Verbal profile manifest by the weak language groups. As previously noted both profiles have high scores on Similarities and Arithmetic, low scores on Information and Digit Span, and intermediate scores on Comprehension and Digit Span on the Verbal profile. The Performance profile for both is characterized by much higher scores than the Verbal profile. The Smc group, as noted in the presentation of results, shows the greatest difference in Verbal and Performance IQs found among all the groups; the Performance IQ is 15.9 points greater than the Verbal IQ. The average score on the Verbal subtests for Smc is 8.55; the average score for Wrc is 9.16. The average score for Smc on the Performance stubests is 11.01; the average score for Wrc is 10.20. The difference between the Verbal subtests mean and the Performance subtests mean for Smc is 2.46; the difference for Wrc is 1.04.

It is, then, the differences in the Performance profiles that demand further analysis. While all the

Performance scores for Smc are higher, the greatest difference between the two profiles, 1.86 points, is between the Picture Arrangement scores. The second largest difference, 1.25 points, is between the Picture Completion scores. The greater difference is significant by *t* test at $p<0.05$, and the second difference approaches significance. Picture Arrangement may measure a specific ability to build sequences into a meaningful whole, a skill required in the construction of verbal sentences and mathematical algorithms. High scores on Picture Arrangement for the strong Mathematics Concepts and Applications subtest, a test which demands both mathematical and language skill, lends support to this conceptualization of what the Picture Arrangement subtest is measuring in addition to sequencing ability. The Smc-Wmc Picture Completion score difference does not so much to represent particular strength of the Smc group as it represents the visual memory weakness already noted in the the Wrv group.

The strong mathematics profile is characterized, then, by relative strength on those WISC-R subtests which reflect reasoning (Similarities, Arithmetic, and to a lesser extent, Comprehension, on the Verbal Scale; Picture Arrangement on the Performance Scale) and relative weakness on the two WISC-R subtests indicative of function of long-term memory: Information and Vocabulary. The apparent difficulty with memory this group manifests may, in part, be a factor of the group's relative field dependence. This group may not be able to recall specific information on demand because of an inability to restructure already encoded information in such a way that an appropriate response is available. Picture Arrangement may represent a specific ability to synthesize sequences into meaningful wholes. The strong mathematics group also shows relatively greater ability than the weak mathematics group to deal with symbolic material. On initial inspection, the most obvious feature of the profile is the nearly 16-point discrepancy between Verbal and Performance IQ scores. The difference in the two means is, by t test, significant at $p < 0.0005$. It is important to note in conclusion that the "strengths" noted here are relative, especially those on the Verbal profile. The weak mathematics group receives marginally higher scores on the WISC-R Arithmetic subtest than does the strong group. The Smc group is probably the least successful group in classroom achievement of the 16 groups examined in this study. An examination of their WISC-R profile shows them to be the lowest group on each of the Verbal subtests, and the large Verbal-Performance discrepancy exhibited by the strong mathematics group is "typical" of many of the lowest achievers seen in the counselling office.

DISCUSSION - CAT SUBTESTS BASED ON MATHEMATICS AND LANGUAGE ABILITIES

It was anticipated that if a profile which reflected weakness in both language and mathematics were to be found, it would be found on the CAT Mathematics Concepts and Applications subtest. The differences between the means of the three groups represented, Smca, Cmca, and Wmca, do not on oneway analysis of variance show differences among their means which are significant at $p \leq 0.05$; although, two subtests do approach that value. The Smca profile is more characteristic of strength in mathematics than in language. It shows relative strength in Arithmetic, Comprehension, and Picture Arrangement; Digit Span is an intermediate score. Unlike the Smc profile, Coding is weak and drops to the level of Information and Vocabulary, the two low Verbal subtests.

The Wmca profile differs from the Wmc profile in that the Similarities-Arithmetic difference is very much reduced, and the Similarities score is much lower for Wmca relative to the rest of the Verbal profile than it is for Wmc. Wmca scores are lower than Smca by the same point difference on each of Picture Arrangement and Block Design. The Wmca weakness on this subtest seems to result primarily from a deficit in reasoning, both verbal and nonverbal, particularly as it involves analysis. There may, as well, be some deficit in the ability to construct meaningful "sentences", both verbal and nonverbal, from sequentially presented stimuli. Field dependence or independence does not seem to be a factor; the difference in GEFT means for the three MCA groups is 0.111 (the means are Wmca 8.000, Cmca 8.065, and Smca 8.111). The difference between Wmca and Smca is, by _t_ test, well below the $p<0.25$ level of significance.

It is probable that the Wmca group performs very poorly in the classroom, yet the WISC-R profile by itself is not likely to suggest that anything is seriously amiss: the Full scale IQ is only a fraction less than the 100 mean score; the 9.43 Performance IQ-Verbal IQ difference is significant only at $p<0.15$; the score ranges are Verbal Scale 1.72 points, Performance Scale 1.42, and overall 3.14. The profiles derived from Mathematics Concepts and Applications are not useful diagnostic tools on their own.

DISCUSSION - CAT SPELLING TEST

The strong spelling group shows a relatively flat profile on both the Verbal and Performance scales. On the Verbal profile, the greatest difference between any two scores is 0.72 scaled score points, and on the Performance profile the range is 0.47 points. The profile is unremarkable when compared to Csp, and the Verbal IQ-Performance IQ difference for Ssp is essentially that of the total research group.

The weak spelling group offers the more interesting profile. The profile shows peaks at Similarities and Block Design that are different from the strong group at the 95 percent level of confidence. The weak spelling group is also significantly more field independent than the strong group. The two subtests and the field independence element share the common quality of being markers for analytical ability. The two subtests may also mark conceptual thinking as opposed to rote memory. It is noteworthy that Digit Span is the weakest of the of the Verbal subtests and almost two scaled score points less than Similarities. On the Performance profile the memory markers, Picture Completion and Coding are the lowest scores, and they fall about a point and a quarter below the average of the of the subtests which require problem solving. These differences are not significant, but they do suggest tendencies that merit further exploration. Additionally, the implication of visual memory deficit is consistent with the association of strength of visualization and superior spelling ability. It would be interesting to replicate this part of this study with speakers of a language that is truly phonetic. It may be that English speakers who attempt to use an analytical or a conceptual approach to English spelling find themselves in trouble because of the language's many phonetic inconsistencies and exceptions to the spelling rules.

DISCUSSION - CAT LANGUAGE MECHANICS SUBTEST

Task analysis of the Language Mechanics subtest in terms of the constructs used in the analyses to this point suggest that success on this subtest should require strength in memory and sequential processing and some strength in verbal expression. No reliable differences indicating such a pattern emerge. On the contrary, there is a tendency, nonsignificant, for the weaker group to show slightly greater strength in language expression and sequencing of meaningful material. The outcomes observed may result from the fact that the Language Mechanics subtest is underlaid by processes not measured with any of the WISC-R subtests, but that seems unlikely. The outcomes on the Language Mechanics subtest may simply reflect the quality of teaching an individual has had more than it does any individual strengths or weakness.

DISCUSSION - CAT SUBTESTS AND WISC-R PROFILES; THE CONCLUSION

The hypothesis that strength or weakness in specific content/skill areas will be reflected in distinct WISC-R profiles is supported for strength and weakness in Reading Vocabulary and for strength and weakness in Mathematics Computation. The general pattern of the strong Reading Vocabulary profile is carried quite consistently through the other CAT subtests based primarily on language ability; that consistency, rather than statistical significance on all profiles, argues for a distinct strong language profile. The same applies to some extent to the weak language profile; however, two subgroups, one based primarily on reading and a second based primarily in language expression and application, arise and dilute the profile.

Strength in mathematics computation yields a Verbal profile which nearly replicates the Verbal profile for weak language. The Performance profiles are not significantly different, but there is a tendency for strength in math to show relatively higher scores on the Picture Arrangement subtest than is evident on the weak language profile. Similarily, the weak math and strong language Verbal profiles show a high degree of correspondence. The full profiles are, however, likely to be separable on the basis of the sharp depression of Block Design relative to the other two scores in the spatial triad in the strong language Performance profile.

A weak spelling profile emerges that may be considered distinctive by the operational definition offered if field independence is admitted as the third significant difference. The poor spellers may rely on conceptual and analytical thinking as compensation for a visual memory deficit.

The following constructs have proved to be the most useful in the analysis of the profiles: sequential or successive vs. simultaneous processing; meaningful (having semantic content) vs. non-meaningful stimuli; verbal vs. symbolic vs. figural material; reasoning vs. memory; analysis vs. synthesis; expressive vs. receptive language; and field dependence vs. field independence.

WISC-R PROFILES -- CLINICAL IMPLICATIONS

It was hoped that one outcome of this study would be the emergence of characteristic WISC-R profiles that would assist school counsellors, school psychologists, other psychologists, and others responsible for psychoeducational assessments in making more precise and differential diagnoses of learning problems in children. In some small measure that hope has been realized.

It is anticipated that the profiles described in this chapter can be used to assist diagnosis in one of three ways. One way in which the profiles can be used is for a practitioner who has examined a child with the WISC-R to compare the resulting profile of that individual with the profiles which emerged in the study. If the profile obtained is similar to one of those derived in the study, the examiner has a hypothesis from which to further explore the child's learning difficulties, and he or she has some confidence that the profile obtained has some statistical support. The examiner should then follow up the WISC-R with the CAT or a similar achievment test to confirm areas of strength and weakness relative to the child's overall level of achievement, i.e., the Total Battery score.

A second approach is to begin with the CAT results. When counsellors screen CAT results, they should note students with areas of particular strength and weakness relative to the Total Battery score, and those students should be followed up with a WISC-R. Perhaps it should be underscored here that particular strength as well as particular weakness should be followed up. The necessity of following up strong CAT scores is demonstrated by considering that strong scores on the Mathematics Computation subtest were paired with WISC-R subtest scores which suggested poor language ability and large Verbal-Performance IQ discrepancies.

The third approach is essentially that taken in this study, and it is, in fact, the approach to diagnosis of learning disabilities or learning difficulties which is ordinarily recommended: the CAT and the WISC-R should both be given, or examined if one or the other or both have been given recently, along with such other assessment instruments as seem appropriate in each case. The individual test results should then be compared with the "template" profiles derived in this investigation. The outcomes will provide the examiner with a number of hypotheses to explore with regard to children in early and middle adolescence.

The profiles obtained and the discussion of each of the profiles ties together for the examiner content/skill deficits which reflect themselves in differential achievement--presumably both on standardized tests and in the classroom--and ability strengths or deficits. The discussion of the profiles and the content/skill deficits reflected provides the counsellor making the assessment with a number of areas to consider, i.e., verbal vs. nonverbal, meaningful vs. non-meaningful content, linguistic vs. symbolic content, simultaneous vs. successive processing and so on, in addition to questions of modal preference, perceptual anomalies, and other observations frequently considered when planning intervention strategies.

The intervention can be approached from a perspective that is more narrowly defined than "a learning disability", yet one that is more general than an entirely unique case; the profiles offer approaches to understanding homogeneous subgroups of children who have difficulty learning certain content and/or skills. While it is undoubtedly true that in the final analysis each child's difficulty is unique, some intermediate scheme of classification between the absolutly unique and the general lable of LD is useful for grouping children and for arranging material for children whose learning difficulties manifest themselves in different content/skill areas and in different patterns of ability and deficit.

CHAPTER 7

RESULTS AND DISCUSSION: FIELD INDEPENDENCE AND INTERACTIONS

HYPOTHESIS II: FIELD DEPENDENCE

The problem of creating cells with an adequate number of cases in each cell to provide meaningful statistics arose, again, in analysis of the field dependence data. Division of the data file on the basis of the four quartiles determined in the standardization of the GEFT with the junior high school group created a female fourth quartile cell with very few cases. The problem was dealt with by determining the quartiles for the total research group and dividing the file on the bases of those quartiles. Table 7-1 compares—the quartiles as determined by the standardization for males and females with those used in analysis. The table indicates that the research sample is relatively less field independent than than the standardization group. This compromise is less than ideal, but it seems preferable to constructing a female fourth quartile WISC-R profile based on only two or three cases; eight is few enough.

RESULTS - FIELD DEPENDENCE, ABILITY AND ACHIEVEMENT

The hypothesis that field independent students would manifest significantly higher IQ scores is confirmed. The IQ scores for each group are reported in Table 7-2. Oneway

TABLE 7-1

COMPARISON OF QUARTILES BETWEEN STANDARDIZATION GROUP AND RESEARCH GROUP

QUARTILE	GEFT SCORE RANGE	NO. OF CASES (R-GRP MEANS BY SEX)	
1st Quartile		Boys	Girls
Research Group	Low - 4.000	23	27
Girls Stdn. Group	0 - 5	(2.48)	(2.63)
Boys Stdn. Group	0 - 6		
2nd Quartile		Boys	Girls
Research Group	4.001 - 8.000	31	24
Girls Stdn. Group	6 - 9	(6.81)	(5.88)
Boys Stdn. Group	7 - 10		
3rd Quartile		Boys	Girls
Research Group	8.001 - 11.000	27	11
Girls Stdn. Group	10 - 12	(10.00)	(9.82)
Boys Stdn. Group	11 - 13		
4th Quartile		Boys	Girls
Research Group	11.001 - high	37	8
Girls Stdn. Group	13 - 18	(14.49)	(15.25)
Boys Stdn. Group	14 - 18		
Means Overall by Group			
Research Group	8.06	(9.10)	(6.31)
Girls Stdn. Group	9.36		
Boys Stdn. Group	10.50		

TABLE 7-2

FULL SCALE, VERBAL, AND PERFORMANCE IQ SCORES FOR FIELD DEPENDENT (1ST QUARTILE), FIELD MIDDLE (2ND & 3RD QUARTILE) AND FIELD INDEPENDENT (4TH QUARTILE) STUDENTS

COGNITIVE STYLE (NO.)	FSIQ (*SD*)	VIQ (*SD*)	PIQ (*SD*)
Field Dependent			
1st Quartile (50)	95.05(7.92)	93.86(9.19)	97.88(10.75)
Field Middle			
2nd Quartile (55)	98.80(7.40)	95.78(8.85)	102.93(8.92)
3rd Quartile (38)	102.08(7.35)	98.50(8.43)	106.29(9.88)
Field Independent			
4th Quartile (45)	105.18(8.72)	98.58(10.08)	112.33(10.11)
(Total No. 188)			

analysis of variance shows significant differences over all the groups on Full Scale IQ (_p_=0.000), Verbal IQ (_p_=0.038), and Performance IQ (_p_=0.000), as reported in Tables 7-3, 7-4, and 7-5. On both Full Scale and Performance IQ, the fourth quartile and the first quartile, the fourth quartile and the second quartile, and the third quartile and the first quartile show between group differences significant at $p \leq 0.01$. Correlations between field dependence scores and WISC-R IQ scores are moderate, 0.36 and 0.41 for FSIQ and PIQ respectively, and low, 0.13, for VIQ. All are, however, statistically significant at the 95 percent level of confidence or greater (for FSIQ and PIQ $p \leq 0.001$).

TABLE 7-3

GROUP DIVIDED BY FIELD DEPENDENCE; WISC-R
VARIABLE: FULL SCALE IQ

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	3	2689.831	896.610	14.521	.0000
Within Groups	184	11361.121	61.745		
Total	187	14050.952			

The two most field independent quartiles score higher on all the subtests of the Verbal Scale save Comprehension, which shows an interesting anomaly. The Comprehension score of the most field independent group, 9.58, almost equals that of the most field dependent group, 9.54, while the two middle groups show nearly identical high scores of 10.24 and

10.25. The differences, though, are not significant. On the Performance Scale, the most field independent group receives the highest scores on all subtests except Coding. The first quartile group (the most field dependent group) scores highest on Coding. In this case, rather than the more field independent group decending to the level of the more dependent group, the field dependent group rises above the other groups. But, again, the differences between the groups are not statistically significant for this subtest. While the anomalous subtests do not show significant

TABLE 7-4

GROUP DIVIDED BY FIELD DEPENDENCE; WISC-R
VARIABLE: VERBAL IQ

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	3	723.099	241.033	2.865	.0380
Within Groups	184	15479.880	84.1298		
Total	187	16202.979			

TABLE 7-5

GROUP DIVIDED BY FIELD DEPENDENCE; WISC-R
VARIABLE: PERFORMANCE IQ

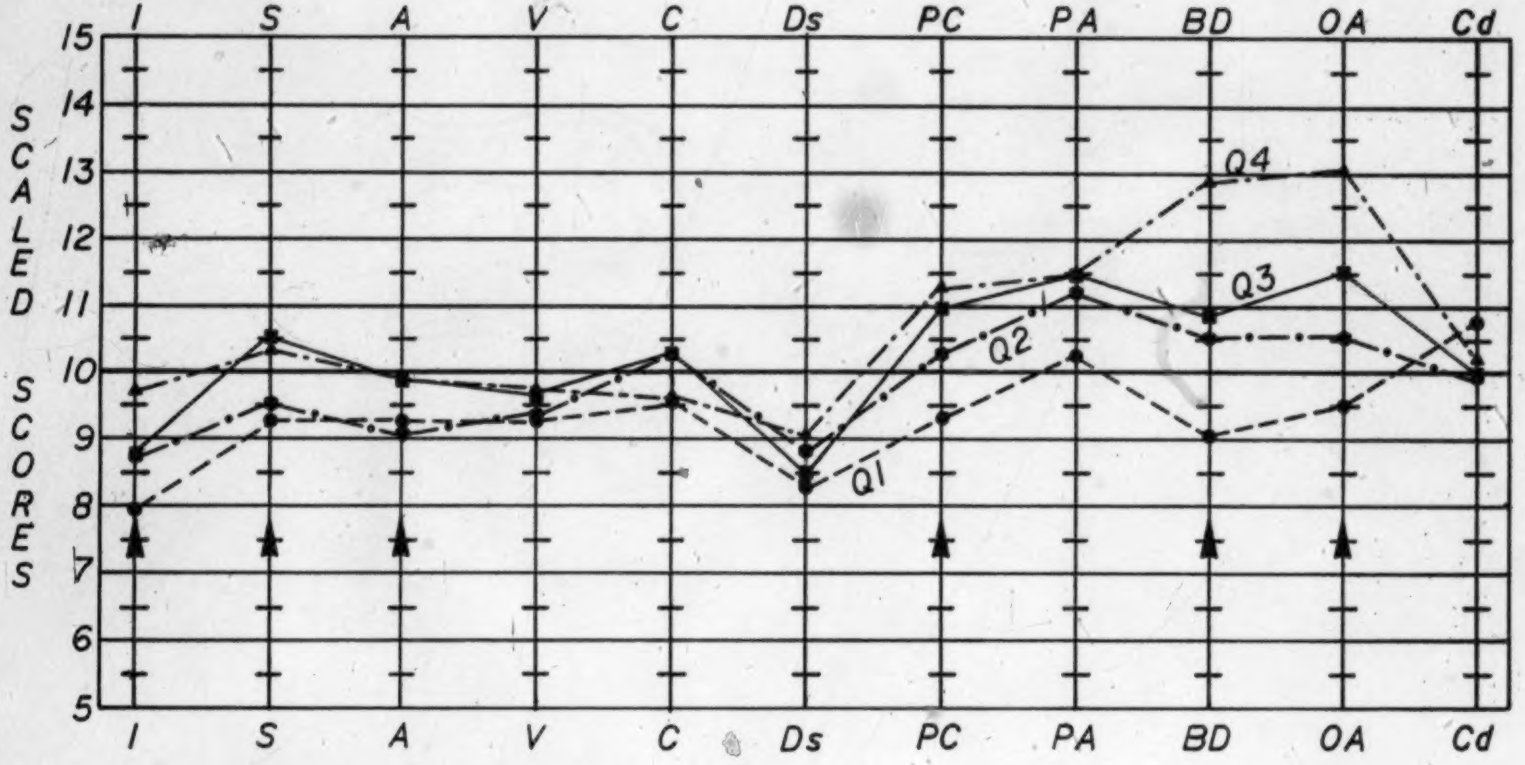
SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	3	5210.147	1736.716	17.687	.0000
Within Groups	184	18066.805	98.189		
Total	187	23276.952			

differences,other subtests do. The profiles for the four levels of field dependence are presented in Figure 7-1. Those profiles are supported by the data in Table 7-6.

There are overall significant differences ($\underline{p} \leq 0.05$) between group means for Information and Similarities on the Verbal scale, but the greatest differences are manifested on the Performance Scale. The score difference between the first quartile and the fourth quartile is 3.59 points on Object Assembly and 3.83 points on Block Design. The most field independent students' mean scores on the BD and OA subtests are 12.89 and 13.09 respectively. The overall differences between the groups for OA and BD are significant at $\underline{p} \leq 0.01$. The PC score differences range from 9.34 for the first quartile to 11.33 for the fourth, a difference of nearly two points. All the scores in the spatial triad are significantly different at $\underline{p} \leq 0.01$. Picture Arrangement showed the second smallest range with 1.25 points between the high first quartile and the low second quartile. The smallest intergroup range was on Coding. The first quartile received the highest score, 10.78; the second quartile received the lowest score, 9.93, a difference of 0.85 points.

Because the anova tables supporting the above also contain other information, i.e., main effects of sex, main effects of CAT divisions, and interaction effects, as well as main effects of field independence, there is a problem of

FIGURE 7-1
WISC-R PROFILE: FIELD DEPENDENCE - TOTAL GROUP



▲ = Difference significant at $p \leq 0.05$

TABLE 7-6

WISC-R PROFILES BY FIELD DEPENDENCE: TOTAL GROUP

WISC-R IQ SCALE	1ST Q-ILE (SD)	2ND Q-ILE (SD)	3RD Q-ILE (SD)	4TH Q-ILE (SD)
Full Scale	95.02 (7.92)	98.80 (7.40)	102.08 (7.35)	105.08 (8.72)
Verbal	93.86 (9.19)	95.78 (8.85)	98.50 (8.43)	98.58 (10.08)
Performance	97.88 (10.75)	102.93 (8.92)	106.29 (9.88)	112.33 (10.11)

WISC-R SUBTEST	1ST Q-ILE (SD)	2ND Q-ILE (SD)	3RD Q-ILE (SD)	4TH Q-ILE (SD)
VERBAL				
Information	7.90 (1.89)	8.71 (2.13)	8.76 (2.10)	9.71 (2.23)
Similarities	9.26 (2.16)	9.51 (2.11)	10.55 (2.60)	10.31 (2.70)
Arithmetic	9.22 (2.10)	9.05 (2.15)	9.89 (2.30)	9.84 (2.58)
Vocabulary	9.22 (2.09)	9.30 (1.78)	9.61 (1.94)	9.71 (1.89)
Comprehension	9.54 (1.94)	10.25 (2.13)	10.25 (1.90)	9.58 (2.09)
Digit Span	8.28 (2.03)	8.81 (2.61)	8.50 (2.08)	9.06 (2.57)
PERFORMANCE				
Picture Comp.	9.34 (2.38)	10.31 (2.30)	10.95 (2.67)	11.33 (2.29)
Picture Arr.	10.24 (3.09)	11.16 (2.55)	11.45 (2.45)	11.49 (2.11)
Block Design	9.06 (2.39)	10.53 (1.93)	10.89 (2.73)	12.89 (2.50)
Object Assem.	9.50 (2.41)	10.53 (2.71)	11.53 (2.26)	13.09 (2.46)
Coding	10.78 (2.35)	9.93 (2.36)	9.97 (1.78)	10.20 (3.21)
No. of Cases	50	55	38	45

appropriate placing of the tables without repeating each as many as four times. To solve the placement problem, all anova tables which include data that are relevant in more than one place in this chapter and which have not been presented previously, e.g., in Chapter 6, are collected on pages 249 to 292 following presentation of the interaction results. The tables are arranged by CAT subtest and WISC-R subtest. The CAT subtests are arranged in the order in which they are administered (Reading Vocabulary, Reading Comprehension, Spelling, Language Mechanics, Language Expression, Mathematics Computation, Mathematics Concepts and Applications, and Reference Skills). Within the CAT subtest grouping, the WISC-R subtests showing significant relationships are arranged in the order in which the subtests are presented on the WISC-R protocol (Information, Similarities, Arithmetic, Vocabulary, Comprehension, Digit Span, Picture Completion, Picture Arrangement, Block Design, Object Assembly, and Coding). Anova tables presented in Chapter 6 are not repeated.

The sub-hypothesis that field independent students would score higher on the Verbal subtests is supported for all the subtests except Comprehension where there is little difference between the combined scores of the two most field independent and two most field dependent quartiles. The pattern is similar for the Performance subtests. The field independent quartiles score higher on all the subtests except Coding, and the combined scores for each of the two high quartiles and two low quartiles differ by less than 0.25 of a point. The anticipated result that the Performance scores between the first and fourth quartiles would differ more than their Verbal scores is also supported. The difference between the Verbal means of the most and least field dependent groups is 0.8 scaled score points while the Performance mean difference is 2.02. In both cases the field independent group manifests the higher mean scores.

A second sub-hypothesis predicted that males would score slightly but significantly higher than females on those WISC-R subtests which correlated most highly with field independence. Table 7-7 reports correlations and the significance levels of the correlations between WISC-R subtest scores and field dependence scores. Correlations between IQ scores and field dependence for the same groups are shown in Table 7-8. Both tables suggest that field dependence is working differently between males and females on different subtests. Differential effects of field dependence are suggested again when the mean scores of all the boys and all the girls are compared for each of the subtests, and that comparison is contrasted with the mean subtest scores obtained by the fourth quartile girls and boys. The scores for the four groups are shown in Table 7-9. When boys and girls are compared without regard to field dependence, the mean scores for boys exceed those of the girls on all the subtests except Digit Span and Coding as shown in Figure 7-2 and Table 7-10. The difference between the Coding scores is significant at $p<0.01$. On the basis of this set of scores, the sub-hypothesis that boys would show significantly higher scores on those subtests which showed the strongest correlations with field independence is supported. The boys show significantly ($p<0.05$) higher scores on Information, Picture Completion,

TABLE 7-7

CORRELATIONS OF WISC-R SUBTEST SCORES WITH FIELD DEPENDENCE (GEFT) SCORES; TWO-TAILED SIGNIFICANCE

SUBTESTS	TOTAL GROUP R/P (N = 216)	MALES R/P (N = 134)	FEMALES R/P (N = 82)
VERBAL			
Information	.227	.198	.169
	.001	.002	.129
Similarities	.177	.094	.319
	.009	.282	.004
Arithmetic	.070	-.018	.142
	.313	.840	.202
Vocab~~ulary~~	.033	.008	.019
	.621	.930	.867
Comprehension	-.016	-.093	.087
	.815	.287	.436
Digit Span	.116	.122	.142
	.089	.162	.202
PERFORMANCE			
Picture Completion	.243	.198	.222
	.000	.022	.045
Picture Arrangement	.130	.103	.106
	.057	.234	.343
Block Design	.466	.355	.620
	.000	.000	.000
Object Assembly	.421	.338	.477
	.000	.000	.000
Coding	-.070	-.049	.095
	.302	.578	.395

Block Design, and Object Assembly. When, however, the scores of the most field independent boys and the most field independent girls are compared, a different picture emerges:

TABLE 7-8

CORRELATIONS OF WISC-R IQ SCORES WITH FIELD DEPENDENCE (GEFT) SCORES; TWO-TAILED SIGNIFICANCE

IQ SCALE	TOTAL GROUP R/P	MALES R/P	FEMALES R/P
Verbal	.137	.053	.208
	.044	.541	.064
Performance	.412	.332	.504
	.000	.000	.000
Full Scale	.363	.268	.445
	.000	.002	.000

TABLE 7-9

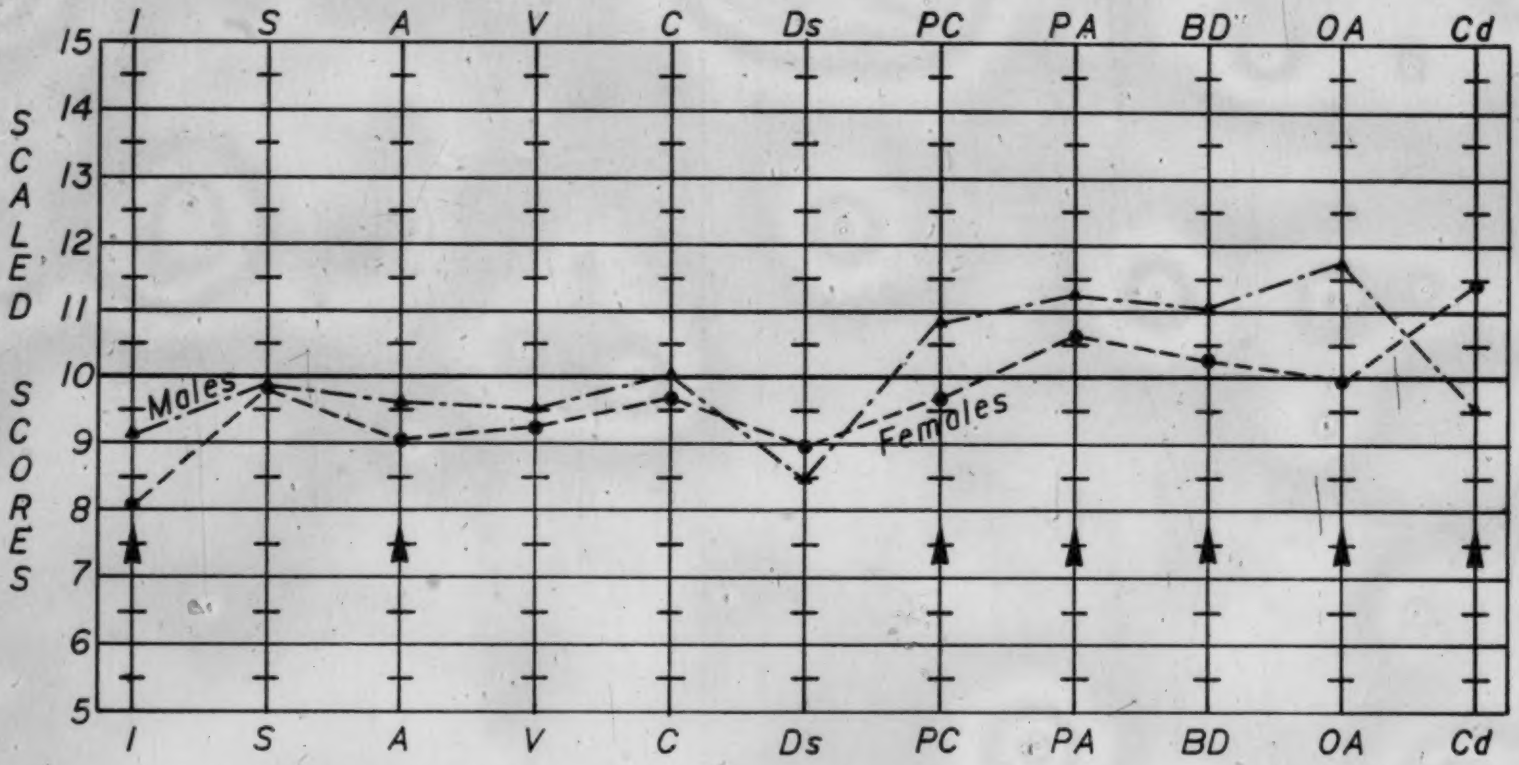
MALE AND FEMALE WISC-R SUBTEST SCORES COMPARED BY TOTAL GROUP AND FOURTH QUARTILE GROUP

	TOTAL GROUP		FOURTH QUARTILE	
SUBTEST	MALES	FEMALES	MALES	FEMALES
Verbal	(n = 118)	(n = 70)	(n = 37)	(n = 8)
Information	9.14	8.09*	9.81	9.25
Similarities	9.86	9.81	10.16	11.00
Arithmetic	9.69	9.06*	9.86	10.63
Vocabulary	9.58	9.21	9.73	9.63
Comprehension	10.03	9.69	9.59	9.50[a]
Digit Span	8.49	8.97	8.81	10.25
Performance				
Picture Completion	10.87	9.67**	11.54	10.38
Picture Arrangement	11.30	10.64*	11.49	11.50
Block Design	11.08	10.26*	12.62	14.13
Object Assembly	11.75	9.93**	13.11	13.00
Coding	9.54	11.39**	9.57	13.13**

a Both second and third quartile scores for both males and females were higher than fourth quartile scores.
* male-female differences significant at $p < 0.05$;
** $p < 0.01$.

FIGURE 7-2

WISC-R PROFILE: MALES – FEMALES



▲ = Difference significant at $p \leq 0.05$

TABLE 7-10
WISC-R PROFILES FOR MALES AND FEMALES

WISC-R IQ SCALE	MALE SCORE (SD)	FEMALE SCORE (SD)
Full Scale	101.30 (8.27)	97.77 (8.92)
Verbal	97.53 (9.16)	94.74 (9.37)
Performance	105.92 (11.25)	102.16 (10.67)
WISC-R SUBTEST	**MALE SCORE (SD)**	**FEMALE SCORE (SD)**
VERBAL		
Information	9.14 (2.10)	8.09 (2.13)
Similarities	9.86 (2.31)	9.81 (2.60)
Arithmetic	9.69 (2.36)	9.06 (2.19)
Vocabulary	9.58 (1.92)	9.21 (1.92)
Comprehension	10.03 (2.17)	9.69 (1.79)
Digit Span	8.49 (2.38)	8.97 (2.30)
PERFORMANCE		
Picture Comp.	10.87 (2.61)	9.67 (2.10)
Picture Arr.	11.30 (2.70)	10.64 (2.44)
Block Design	11.08 (2.72)	10.26 (2.65)
Object Assem.	11.75 (2.83)	9.93 (2.36)
Coding	9.54 (2.17)	11.39 (2.59)
Number of Cases	118*	70*

* Only students with GEFT scores are included here.

the girls out score the boys on six of the subtests and nearly equal them on a seventh. The differences, while not statistically significant, do suggest a differential effect of field independence between boys and girls and foreshadow significant interaction effects to be developed in a following section. Profiles illustrating the differential effects of field dependence on the WISC-R scores of males and females are presented in Figures 7-3 and 7-4 and supported by Tables 7-12 and 7-13 respectively.

A third part of the hypothesis predicted that the field independent group would score significantly higher than the field dependent group on measures of achievement. Actual scores for the four groups are reported in Table 7-11.

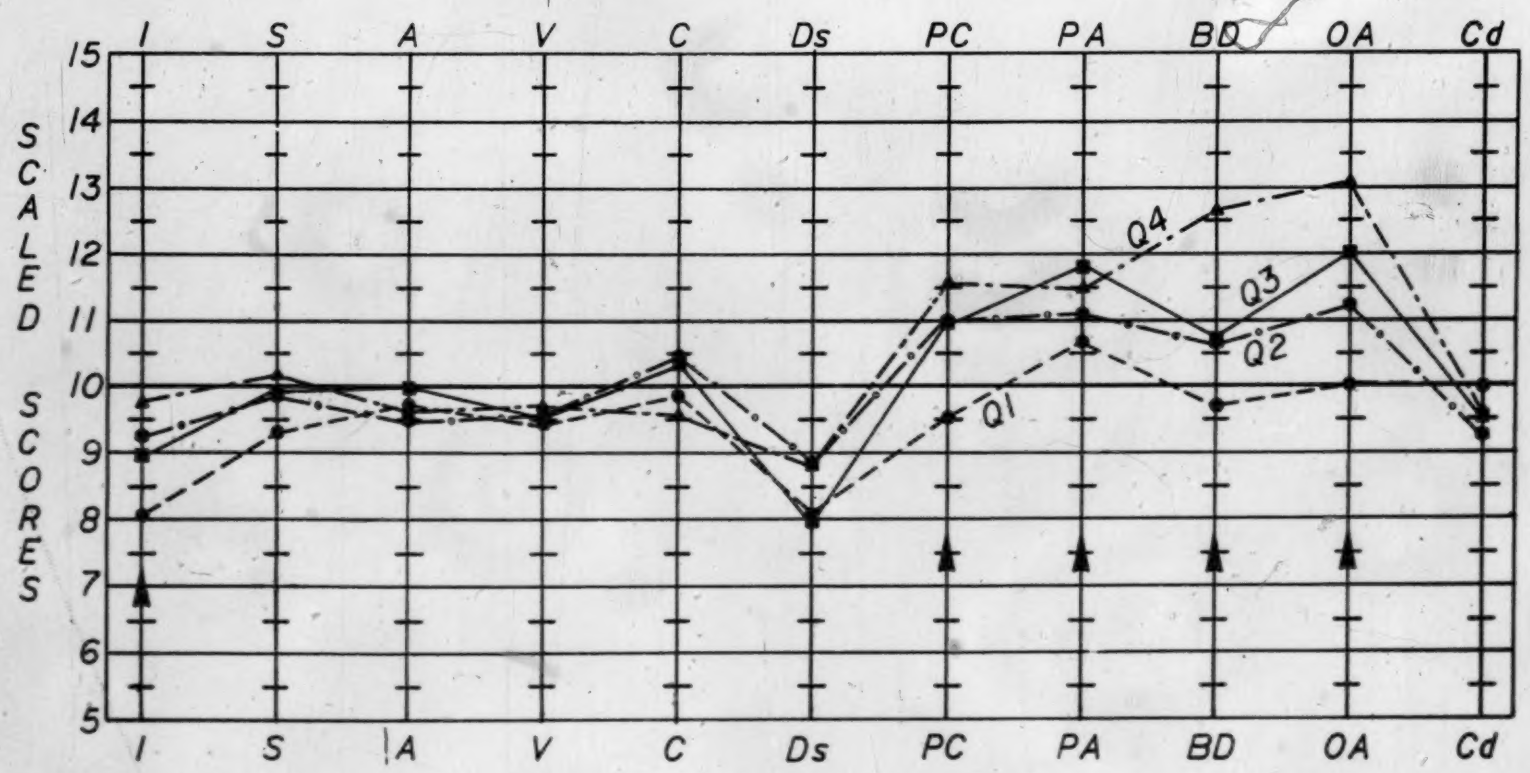
TABLE 7-11

COMPARISON OF CAT SUBTEST SCORES BY FIELD DEPENDENCE

CAT SUBTEST	FIRST Q-ILE	SECOND Q-ILE	THIRD Q-ILE	FOURTH Q-ILE	(OVERALL SIGN.)
Reading Voc.	518.82	510.27	514.21	566.20	(.0001)
Reading Comp.	537.94	524.78	536.03	579.69	(.0001)
Spelling	538.94	520.58	514.92	537.56	(.2833)
Lang. Mech.	549.78	525.95	535.95	557.73	(.0845)
Lang. Express.	544.10	520.67	538.37	560.62	(.0316)
Math Comput.	495.14	474.24	496.05	504.44	(.0453)
Math Con. & App.	501.94	484.94	502.39	537.24	(.0005)
Reference Skills	533.26	513.91	532.92	575.91	(.0001)

FIGURE 7-3

WISC-R PROFILE: FIELD DEPENDENCE - MALES



▲ = Difference significant at $p \leq 0.05$

TABLE 7-12

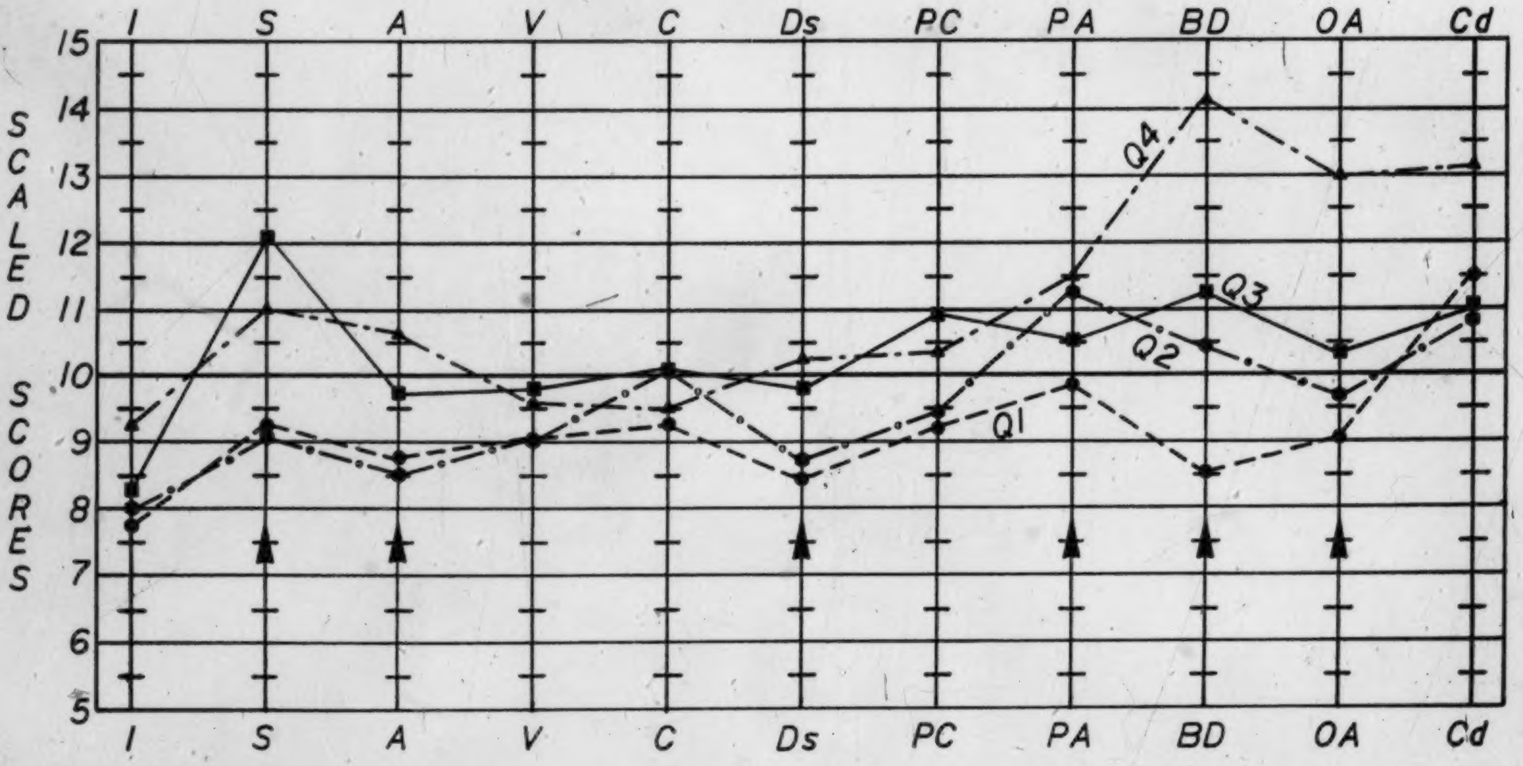
WISC-R PROFILES BY FIELD DEPENDENCE: MALES

WISC-R IQ SCALE	1ST Q-ILE (*SD*)	2ND Q-ILE (*SD*)	3RD Q-ILE (*SD*)	4TH Q-ILE (*SD*)
Full Scale	96.35 (8.70)	100.52 (8.02)	101.96 (7.34)	104.54 (7.53)
Verbal	95.22 (9.49)	97.87 (9.64)	97.96 (7.22)	98.35 (9.89)
Performance	99.00 (13.33)	103.90 (9.33)	106.67 (10.79)	111.35 (9.00)

WISC-R SUBTEST	1ST Q-ILE (*SD*)	2ND Q-ILE (*SD*)	3RD Q-ILE (*SD*)	4TH Q-ILE (*SD*)
VERBAL				
Information	8.09 (1.76)	9.26 (2.38)	8.96 (1.70)	9.81 (2.12)
Similarities	9.30 (2.24)	9.87 (2.19)	9.93 (1.92)	10.16 (2.69)
Arithmetic	9.70 (2.12)	9.48 (2.08)	9.96 (2.61)	9.68 (2.60)
Vocabulary	9.43 (2.31)	9.55 (1.80)	9.52 (1.81)	9.73 (1.90)
Comprehension	9.87 (2.14)	10.42 (2.33)	10.30 (1.86)	9.59 (2.25)
Digit Span	8.09 (1.93)	8.87 (3.10)	7.96 (1.43)	8.81 (2.48)
PERFORMANCE				
Picture Comp.	9.52 (2.81)	11.00 (2.31)	10.96 (2.84)	11.54 (2.33)
Picture Arr.	10.65 (3.83)	11.10 (2.62)	11.81 (2.42)	11.49 (2.06)
Block Design	9.65 (2.62)	10.61 (2.17)	10.74 (3.05)	12.62 (2.29)
Object Assem.	10.00 (2.49)	11.19 (3.10)	12.00 (2.30)	13.11 (2.50)
Coding	9.96 (2.08)	9.23 (1.86)	9.52 (1.60)	9.57 (2.79)
No. of Cases	23	31	27	37

FIGURE 7-4

WISC-R PROFILE: FIELD DEPENDENCE - FEMALES



▲ = Difference significant at $p \leq 0.05$

TABLE 7-13

WISC-R PROFILES BY FIELD DEPENDENCE: FEMALES

WISC-R IQ SCALE	1ST Q-ILE (SD)	2ND Q-ILE (SD)	3RD Q-ILE (SD)	4TH Q-ILE (SD)
Full Scale	93.89 (7.15)	96.58 (5.94)	102.36 (7.74)	108.12 (13.20)
Verbal	92.70 (8.85)	93.08 (7.02)	99.82 (11.17)	99.63 (11.59)
Performance	96.93 (13.33)	101.67 (9.33)	105.36 (10.79)	116.88 (9.00)

WISC-R SUBTEST	1ST Q-ILE (SD)	2ND Q-ILE (SD)	3RD Q-ILE (SD)	4TH Q-ILE (SD)
VERBAL				
Information	7.74 (2.01)	8.00 (1.53)	8.27 (2.90)	9.25 (2.82)
Similarities	9.22 (2.12)	9.04 (1.94)	12.09 (3.45)	11.00 (2.78)
Arithmetic	8.81 (2.04)	8.50 (2.15)	9.73 (1.35)	10.63 (2.50)
Vocabulary	9.04 (1.91)	9.00 (1.74)	9.82 (2.32)	9.63 (2.00)
Comprehension	9.26 (1.75)	10.04 (1.85)	10.09 (2.07)	9.50 (1.20)
Digit Span	8.44 (2.14)	8.75 (1.87)	9.82 (2.82)	10.25 (2.82)
PERFORMANCE				
Picture Comp.	9.19 (1.98)	9.42 (2.00)	10.91 (2.34)	10.38 (1.93)
Picture Arr.	9.89 (2.29)	11.25 (2.51)	10.56 (2.38)	11.50 (2.51)
Block Design	8.56 (2.08)	10.42 (1.61)	11.27 (1.79)	14.13 (3.18)
Object Assem.	9.07 (2.30)	9.67 (1.83)	10.36 (1.75)	13.00 (2.39)
Coding	11.48 (2.38)	10.83 (2.66)	11.09 (1.76)	13.13 (3.56)
No. of Cases	27	24	11	8

There are significant ($\underline{p} \leq 0.05$) overall differences between the field dependent and field independent students on Reading Vocabulary, Reading Comprehension, Language Expression, Math Computation, Math Concepts and Application, and Reference Skills as shown in Tables 7-14 through 7-19. On Spelling, the most field dependent group scored slightly higher than the most field independent group, but the difference is negligible. One interesting result is that the most field independent group scored significantly

TABLE 7-14

CAT STANDARD SCORES BY FIELD DEPENDENCE
CAT SUBTEST: READING VOCABULARY

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	3	94085.360	31361.787	7.622	.0001
Within Groups	184	757123.805	4114.803		
Total	187	851209.165			

TABLE 7-15

CAT STANDARD SCORES BY FIELD DEPENDENCE
CAT SUBTEST: READING COMPREHENSION

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	3	81864.898	27288.299	7.712	.0001
Within Groups	184	651036.820	3538.244		
Total	187	732901.718			

TABLE 7-16

CAT STANDARD SCORES BY FIELD DEPENDENCE CAT SUBTEST: LANGUAGE EXPRESSION

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	3	40623.631	13541.210	3.008	.0316
Within Groups	184	828206.029	4501.120		
Total	187	868829.660			

TABLE 7-17

CAT STANDARD SCORES BY FIELD DEPENDENCE CAT SUBTEST: MATHEMATICS COMPUTATION

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	3	25381.281	8460.427	2.729	.0453
Within Groups	184	570342.953	3099.690		
Total	187	595724.234			

TABLE 7-18

CAT STANDARD SCORES BY FIELD DEPENDENCE CAT SUBTEST: MATHEMATICS CONCEPTS & APPLICATION

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	3	70411.685	23470.562	6.198	.0005
Within Groups	184	696813.592	3787.030		
Total	187	767225.277			

TABLE 7-19

CAT STANDARD SCORES BY FIELD DEPENDENCE
CAT SUBTEST: REFERENCE SKILLS

SOURCE OF VARIANCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between Groups	3	98687.656	32895.885	7.2152	.0001
Within Groups	184	838900.573	4559.242		
Total	187	937588.229			

higher than the most field dependent group on a between groups analysis of Reading Vocabulary ($\underline{p} \leq 0.01$), Reading Comprehension ($\underline{p} \leq 0.05$), and Reference Skills ($\underline{p} \leq 0.05$); but the most field independent group and the second most field dependent group (the second quartile) showed significant between group differences on Reading Vocabulary ($\underline{p} \leq 0.01$), Reading Comprehension ($\underline{p} \leq 0.01$), Language Expression ($\underline{p} \leq 0.05$), Math Concepts and Application ($\underline{p} \leq 0.01$), and Reference Skills ($\underline{p} \leq 0.01$). For the most part, the differences between the first and second quartile scores are not large, yet on Spelling, Language Mechanics, Language Expression, and Math Computation, the first quartile group stands closer to the fourth group than it does to the second quartile group.

It was asserted that the greatest differences between field dependent and field independent students would be on the Language Expression, Math Concepts and Applications, and Reference Skills on the basis that these subtests require the greatest analysis and restructuring of information. Contrary to expectations, Reading Vocabulary and Reading Comprehension showed greater and more significant differences between the field dependence divisions than did Language Expression and Mathematics Concepts and Application, although the mathematics test did achieve significance at $\underline{p} \leq 0.05$. Mathematics Computation, a subtest that would appear to require mimimal restructuring, also showed significant differences between the field dependent and independent groups.

The broad form of the hypothesis that field independent students would show both superior ability and achievement is supported. The two exceptions, higher first quartile scores on the WISC-R Coding subtest and on the CAT Spelling subtest, are in neither case significant. The most field independent group scores significantly higher on all three WISC-R IQ scores than does the most field dependent group, and the CAT subtest mean for the fourth quartile group is significantly ($\underline{p} \leq 0.01$) greater when compared through anova with each of the the means of the other three quartiles. There is compelling evidence that field dependence is a factor in ability as measured by the WISC-R and achievement as measured by the CAT. The nature of the interaction is, however, complex.

DISCUSSION - FIELD DEPENDENCE, ABILITY, AND ACHIEVEMENT

Field dependence does not equally influence all aspects of ability as measured by the WISC-R. The Information, Picture Completion, Block Design, and Picture Completion subtests are most influenced by field dependence scores for both males and females. Similarities is strongly correlated with field dependence for girls but not for boys, and field dependence which accounts for approximately 11 percent of the variance in boys' Block Design scores, accounts for 38 percent of the variance in the girls' on the same subtest. These observations are expanded in the discussion of interactions to follow as a separate section.

Field dependence also shows significant main effects at greater than the 95 percent level of confidence with six of the eight CAT subtests: Reading Vocabulary, Reading Comprehension, Language Expression, Mathematics Computation, Mathematics Concepts and Applications, and Reference Skills. It was not anticipated that the Reading Vocabulary subtest or the Mathematics Computation subtest scores would be significantly influenced by field dependence.

The review of literature dealing with field dependence suggests a number of reasons why field independent students would achieve higher scores on both ability and achievement tests. Field independent (FI) persons are task-oriented, internally motivated, not dominated by the most salient visual stimulus of a field, and are able to attend selectively to stimulus fields and to restructure those fields to meet the needs of the task at hand. Field independent persons also tend to be more sensitive to subtle differences in stimuli than are field dependent (FD) persons. The fine discrimination exhibited by field independent persons seems to extend beyond visual stimuli to kinesthetic and auditory stimuli as well. All of these abilities should contribute to success on the tasks included in the WISC-R and CAT.

However, the traits or characteristics listed lend little in explaining why the most field independent groups do not do better on all the subtests of the WISC-R and the CAT. Further, they deal more with the functional outcomes of cognitive processing rather than the nature of that processing, and it is the nature of that processing that is of greater interest here.

Cohen, Berent, and Silverman (1973) suggest that the tasks on which field dependent and field independent persons manifest differences, e.g., the Rod and Frame Test and spatial forms tests, have two processes which contribute to success. Those processes are scanning and field articulation. Scanning refers to the extensiveness to which the data from a stimulus field is sampled. Field articulation is described as meaningfully sorting of the elements of the field which are relative to the task. Cohen et al. suggest that scanning is mediated by the right hemisphere and articulation by the left hemisphere. Success depends on integration of the two tasks. Bloom-Feshback (1980) asserts that the cognitive differentiation of field independent persons implies strong interhemispheric integration. Kaufman (1979) identifies Picture Arrangement, Block Design, Coding, and Mazes as subtests requiring integration between the hemispheres for processing, and Picture Completion and Object Assembly as right-hemisphere tasks.

The results obtained in this study show that Block Design and Object Assembly are the two tasks which discriminate maximally between field dependent and field independent subjects. Coding and Picture Arrangement discriminates least between the groups. The tests which demand integrative processing appear to work differentially. Block Design is highly discriminative while Picture Arrangement and Coding, for the total group at least, discriminate less effectively. In light of this observation, a reasonable assumption, if one integrates Cohen et al., Bloom-Feshback, and Kaufman, is that field dependence and field independence are strongly influenced by the processor's scanning ability. Both Object Assembly and Picture Completion, which Kaufman equates with right-hemisphere processing, show statistially significant score differences between field dependent and field independent students.

There are, nonetheless, problems with this conceptualization. Picture Arrangement, which like Picture Completion, requires attention to detail, and which, like Object Assembly, requires the synthesis of a meaningful visual whole, does not show statistically significant differences between the groups. However, an alternative conceptualization does get all the subtests on the proper sides of the equation. The approach suggested is to conceive of the various subtests that discriminate strongly as representing differences in the facility for successive and simultaneous processing. Kaufman associates Picture Completion, Block Design, and Object Assembly with simultaneous processing and Picture Arrangement, Coding, and Mazes with successive processing.

Picture Completion, Block Design, and Object Assembly are all presumed to require simultaneous processing. All of these subtests discriminate between the field dependent and field independent at the 95 percent level of confidence or greater. And, while there are differential interactions with sex, the total group results show significant quartile differences in the Similarities subtest scores, the Verbal subtest most likely to require simultaneous processing. Two of the three Performance subtests marking successive processing, Picture Arrangement and Coding, do not show significant differences. The subtest most certainly requiring successive processing, apart from the subtests marking expressive language abilities, is Digit Span, and the differences between the field dependent and the field independent groups' Digit Span scores are not significant.

It will be useful to examine the concepts of successive and simultaneous processing more closely before beginning the discussion of the relationship of field dependence to the achievement results. The following summary is drawn from papers published by J.P. Das and his colleagues (Cummins & Das, 1978; Das, 1973; Das, Kirby, & Jarman, 1975). Simultaneous processing is involved in reasoning, understanding of relationships, and the formation of any holistic gestalt. It is involved in the comprehension of certain linguistic constructions described as "quasi-spatial logical grammatical constructions." Comparative constructions of the form "taller than", "less than" and "greater than" are included in this categorization as well as some spatial prepositions such as "above", "below", and "beside". Some relationships of the form "father's brother" and "brother's father" fall into the same category and require simultaneous processing. Simultaneous processing is also required to bring sequentially received information into wholes with quasi-spatial overtones. Perception of spatial relations--right, left, east, west--requires simultaneous processing. Math calculations which require the preservation of an interior quasi-spatial distribution of numerical elements will be processed simultaneously. The processing of concrete words and of images also seems to demand this mode of processing. And, finally, the nominative function of language involves simultaneous processing.

Successive synthesis or processing is thought to be the represented in association learning or rote memory where there is little transformation of the stimulus. Production and comprehension of ordered sequences, and in particular, temporally organized successive series including narrative speech require successive synthesis. The ability to produce and comprehend language demands a successive automatization function. The syntactical aspects of language require successive processing. Finding verbs (predicate forms) to link separate items into a whole seems to call for successive synthesis. Comprehension of abstract words is, according to the authors mentioned, linked to successive processing. Finally, any system which is not totally surveyable at one time will demand successive processing.

The simultaneous-successive construct is complex. It is complicated by a third cognitive operation: thinking which involves planning, organizing, and decision-making. This system interacts with the other two; and they, in turn, interact with each other, making it extremely difficult to isolate the cognitive components of each. Nevertheless, the construct seems to be useful in the exegesis of the results obtained in this research.

While Das and his colleagues make it clear that successive processing is not uniquely associated with language processing, it is clear that there is a strong association between them. How then is the strong relationship between field independence and achievement on the CAT subtests, all of which require a greater or lesser degree of language processing, to be explained? Field dependence/field independence has the greatest influence on those CAT tests which demand language comprehension and the ability to restructure information presented in linguistic form to meet the needs of the task at hand. This seems to be straight forward and is not at odds with the association of field independence and simultaneous processing which seems apparent on analysis of the relationships between field dependence and the WISC-R subtests. The test apparently at odds with the pattern is Reading Vocabulary which on first look would seem to be based primarily on rote memory and/or associative learning; tasks which are identified as requiring successive processing. There appears to be little required in the way of restructuring and little demand for processing quasi-spatial relationships in the Reading Vocabulary subtest.

The explanation of the unexpected relationship between success in Reading Vocabulary and field independence may lie in comments in the Class Management Guide for the CAT (CTC/McGraw-Hill Ryerson, 1983). The authors note that the "stimulus word is placed in a phrase or short sentence." And that "The phrase or sentence helps create a 'mental image' for the student and helps clarify the word" (p. 11). It may well be that the phrase or short sentence forces the task beyond word association and requires the student to find another word that will stand in the same (or opposite, depending on the section of the test) relationship to the phrase or sentence as does the stimulus word. If such is the case, then an argument can be made that the task is one that requires simultaneous synthesis.

In addition to an apparent positive relationship with a facility for simultaneous processing, field independence seems to involve a number of other factors which will contribute to high scores on achievement and ability measures. Such factors may, in fact, be the stuff of which simultaneous processing is made. Those factors include a penchant to perceive and discriminate figure-ground relationships, to perceive patterns in those relationships (gestalt closure), to recognize those patterns on their reappearance, and to attend to detail--the scanning factor. Analytical ability, including the capacity to shift attention and to reorganize the patterns preceived, is another salient aspect of field independence. There seems to be, as well, a proclivity to impose structure on material encoded. That imposition of structure may center around the assignment of meaning to experience or particular experience. That same structured encoding may contribute to superior recall which would help explain the superior scores the field independent group achieves on the Information subtest.

It is interesting to speculate that field independent persons have a highly discriminative match-mismatch mechanism, and that incoming stimuli are filtered or, perhaps better, parsed through that mechanism. The notion of parsing, borrowed from sentence analysis, conveys important aspects of the system: hierarchy, structure, and analysis. Such a mechanism may be analogous to computer circuits made of a great number of hierarchically arranged switches which code in terms of on-off. In this analogy, the difference between field dependent and field independent persons would be the number of circuits or switches available. Given the apparent affinity of field independence for visual stimuli, it is tempting to expand the analogy to suggest that the field independent individual's indwelling computer has a well developed graphics capacity.

The foregoing has been presented somewhat forcefully; perhaps two disclaimers are in order. First, the proposition advanced is not that field independent persons are simultaneous processors in lieu of being successive processors. They may well possess strength in both. Strength in one mode of processing does not necessarily preclude strength in the other, although, there is some data that may be interpreted to suggest that one mode can interfere with the other. The second disclaimer is that what is said here should not necessarily be taken to support the notion advanced by Das and his co-researchers that the processes discussed are located in the fronto-temporal and occipital-parietal lobes of both hemispheres rather than the right and left hemispheres, as the more conventional view suggests. It does seem, however, that 'simultaneous processing' may be a more descriptive term than 'global processing' and that the two are not entirely synonomous.

The comments above conclude this discussion of field dependence, ability, and achievement. Discussion of the interactions observed will necessitate a second look at field dependence and its differential interactions with sex and the various CAT divisions.

HYPOTHESIS II A: RESULTS SUBSETS OF WISC-R SUBTESTS

It would have been remiss, given the data gathered, to have failed to look at the subsets of WISC-R subtests which have been associated with LD in the literature. This section briefly examines the relationship of field dependence/independence with the Picture Completion-Block Design-Object Assembly triad (Bannatyne's Spatial Category), the Arithmetic-Digit Span-Coding triad (Bannatyne's Sequential Category and Kaufman's Third Factor), the ACID profile, and Verbal-Performance IQ differences. Two additional subsets are examined. One is VIDA. In a pilot study for this thesis, Vocabulary often replaced Coding as one of the four low tests associated with the ACID profile. Finally, an analysis dyad composed of Similarities and Block Design is examined in its relation to field dependence.

As predicted, the spatial triad correlated significantly with field dependence. The correlations are as follows: total research group 0.50, males 0.40, and females 0.57. All correlations are significant at p=0.000. A common factor, analysis, is confirmed in Similarities, Block Design, and GEFT scores. The correlations for the Similarities-Block Design dyad with field dependence (GEFT) scores are 0.43 for the total group, 0.32 for males, and 0.57 for females; all are significant at p=0.000

Contrary to expectations, the subtest subsets primarily composed of subtests from the Verbal Scale also showed positive correlations with field dependence measures. In fact the subset completely contained in the Verbal Scale, VIDA, showed a slightly stronger correlation with field dependence scores in the total group than did ACID. The correlations are 0.14 (p=0.042) and 0.16 (p=0.021) for ACID and VIDA respectively. These subsets also show the differential effects field dependence has for males and females. Male scores correlate less well than female scores, and the correlations, 0.11 for ACID and 0.08 for VIDA, are not significant at $\underline{p} \leq 0.05$. Female field dependence scores correlate at 0.22 for ACID and 0.22 for VIDA. Both correlations are significant at $\underline{p} \leq 0.05$.

The Third Factor showed low and nonsignificant positive correlations with Group Embedded Figures Test scores. Differential effects of field dependence on female and male WISC-R scores were again reflected. The correlation of the Third Factor scores for females was 0.19 ($\underline{p}=0.09$), for males it was 0.03 ($\underline{p}=0.71$). These are lower correlations, especially for the males, than were anticipated.

The prediction that field independent students would manifest greater Verbal-Performance IQ discrepancies, and that the Performance IQs would be greater is confirmed. The total group exhibits a mean Performance IQ that is greater than its mean Verbal IQ by 8.46 points. The influence of field dependence on IQ score differences is shown in Table 7-20. As anticipated, the score differences grow with increasing field independence. The overall difference as determined by oneway analysis of variance is significant at $\underline{p} \leq 0.01$, and the between groups difference for the most field independent (fourth quartile) and the most field dependent (first quartile) of 9.73 points is significant at $\underline{p} < 0.05$.

The male-female differences in response to field dependence are again reflected. However, there is an unexplained anomaly in the third quartile.

TABLE 7-20

PERFORMANCE IQ - VERBAL IQ DIFFERENCES BY LEVELS OF FIELD DEPENDENCE

QUARTILE	TOTAL GROUP DIFFERENCES	MALE DIFFERENCES	FEMALE DIFFERENCES
1st Quartile (Field Dependent)	4.02	3.78	4.23
2nd Quartile	7.15	6.03	8.59
3rd Quartile (Field Middle)	7.79	8.71	5.54
4th Quartile (Field Independent)	13.76	13.00	17.25

DISCUSSION - SUBSETS OF WISC-R SUBTESTS

Given the well established association in the literature of field independence and success on the spatial subtests, the finding here requires little additional comment. The results obtained here once more confirm that field independent students score well on those subtests which measure spatial abilities. The three spatial subtests, Picture Completion, Block Design, and Object Assembly, constitute three-fifths of the Performance score. These tests and the Performance IQ show higher correlations with field dependence measures than do the Verbal Scale subtests; hence, it in not surprising that the field independent group would obtain greater

Performance than Verbal IQ scores, and little further comment seems required.

Stronger than expected correlations of field dependence scores with both Information and Digit Span scores for both males and females as well as higher correlations of field dependence scores with Arithmetic and Coding scores for females seem to have been enough to to draw the ACID and VIDA subsets into positive correlations with GEFT scores. It seems not unreasonable to suggest that the superior ability of field independent persons to break up stimulus fields into various elements and to perceive figure ground relationships will facilitate performance on both Information and Arithmetic. Performance on the Information subtest in particular may be related to the ability to attend to specific elements and to bring those elements into various relationships. The field dependent person may have more difficulty finding a specific element--the answer to an Information question--because he or she has encoded whatever information he or she has in a global fashion and may not be able to sort and recover the specific element or detail which is the answer to the question presented. Success in Arithmetic, at least for girls, may also be a factor of sorting and focussing elements of relevant and irrelevant information.

The question of positive correlations with Digit Span, because the subtest appears to be paradigmatic of a sequential test, requires a closer, if speculative, look. It may be that the low but positive correlations between Digit Span and field independence are simply a reflection of greater overall intelligence, and that the common factor is g. Since Digit Span is not a good measure of g, this is a rather tenuous hypothesis. A more tenable hypothesis may be that the difference between the groups lies in how the field dependent and field independent students scored on the digits backward part of the subtest. It is conceivable that the better ability of the field independent student to restructure a stimulus field may give him or her an advantage on digits backward, and that it is the score changes that result from the digits backwards part of the score that yield the positive correlations. This hypothesis is testable but not within this project as raw WISC-R scores were not recorded.

The prediction of a positive correlation between the Third Factor subtests and field independence was made on the expectation that an attentional factor would be operating with both scores to be correlated. Task-orientation, attention to detail, the ability to shift attention from one stimulus element to another within a field, and the ability to focus attention selectively are all attributes of field independent persons according to the literature reviewed. It is reasonable to assume that these qualities would come into play on those WISC-R tasks that demand a high level of attention, namely Arithmeic, Digit Span, and Coding. If this reasoning is correct, then a somewhat greater correlation between the Freedom from Distraction factor and field dependence should be expected. Perhaps it is appropriate to recall at this point that the Third Factor is the ACID subset with Information removed. The Information subtest may be taken as an indicator of awareness or general level of attention to the environment. When Information is viewed as another indicator of attention, the fact that its removal from the Third Factor precipitates a decline in correlation with the field dependence score seems to have, in conjuction with the previous observations in this paragraph, a negative relevance to the conceptualization of the Third Factor as a measure of attention. The low correlation may suggest that the Third Factor can better be thought of in an alternative construct, i.e., as a sequential factor as proposed by Bannatyne or as a symbolic factor as it becomes under a System of Intellect interpretation (Kaufman 1979, p. 73). Discussion of the implications for male-female differences is withheld to be discussed in conjunction with other interactions.

In conclusion, Hypothesis II A produces few surprises when viewed in the light of previous literature and the results discussed earlier in this research report. Perhaps the most interesting finding is that last treated, namely, that it may be worthwhile to examine the utility of the Arithmetic, Digit Span, and Coding subtests as a measure of attention. When examined in relation to field independence, it behaves more as a sequential, or, conceivably, as a symbolic factor. Results in this section, including those found for the Third Factor, continue to suggest that field independence acts differentially between boys and girls.

HYPOTHESIS IIB: THE INTERACTIONS

RESULTS - THE INTERACTIONS

Multiple analysis of variance of the form, WISC-R subtest by field dependence by sex for each of the CAT divisions yields a number of main effects and a number of interactions. Main effects and interactions significant at $p \leq 0.05$ are shown in Table 7-21. The lower case 'a' marking some CAT divisions indicates that all the divisions were significant at the level specified.

There are, as well, significant sex by CAT division and field dependence by CAT division interactions influencing WISC-R scores. Those interactions, their levels of significance, and the WISC-R scores are reported in Tables 7-22 and 7-23. In this case, interactions to $p<0.059$ are reported as a number of cases fall in the $p=0.05$ to $p=0.06$ range. Significant main effects of the CAT divisions themselves are

TABLE 7-21

MAIN AND INTERACTION EFFECTS OF FIELD DEPENDENCE AND SEX ON WISC-R SUBTEST SCORES: RANGE OF SIGNIFICANCE THROUGH CAT DIVISIONS

WISC-R SUBTESTS	M.E. WITH FD	M.E. WITH SEX	INTERACTION FD X SEX
Information	.005-.011	.005-.05	n.s
Similarities	.02-.041	n.s.	.01-.050
Arithmetic	n.s.	n.s.	.049*
Vocabulary	n.s	n.s.	n.s.
Comprehension	.048*	n.s	n.s.
Digit Span	n.s.	.018*	n.s.
Picture Completion	.004-.014	.011-.030	n.s.
Picture Arrangement	n.s	n.s.	n.s.
Block Design	.000^a	n.s.	n.s.
Object Assembly	.000^a	.002-.013	n.s.
Coding	n.s:	.000^a	n.s.

* This level of significance on one CAT division only; others not significant at $\underline{p} \leq .05$

reflected in the levels of significance recorded to $\underline{p}$=0.059 range.

Analysis of variance tables supporting the results discussed in Chapter 7 and which have not already been presented are included following Tables 7-22 and 7-23. As previously indicated, the tables are arranged first by CAT subtest and then by WISC-R subtest in their familiar order within the CAT subtest divisions.

TABLE 7-22

INTERACTION OF SEX WITH CAT DIVISIONS: LEVEL OF SIGNIFICANCE AND WISC-R SCORES

WISC-R SUBTESTS	CAT DIVISION (P=X.XXX)		WISC-R SCORES	
			MALE (N)	FEMALE (N)
Information	Sp (0.041)	Wsp	9.38 (13)	9.60 (5)
		Csp	9.11 (97)	7.74 (54)
		Ssp	9.00 (8)	9.09 (11)
Similarities	n.s			
Arithmetic	n.s.			
Vocabulary	Sp (0.05)	Wsp	10.15 (13)	9.60 (5)
		Csp	9.59 (97)	9.09 (54)
		Ssp	8.50 (8)	9.64 (11)
Comprehension	RC (0.056)	Wrc	9.50 (14)	11.00 (3)
		Crc	10.00 (88)	9.65 (62)
		Src	10.63 (16)	9.40 (5)
	MC (0.05)	Wmc	11.67 (12)	9.88 (8)
		Cmc	9.83 (94)	9.76 (58)
		Smc	9.92 (12)	8.25 (4)
Digit Span	n.s.			
Picture Comp	LE (0.002)	Wle	10.87 (15)	11.50 (2)
		Cle	10.60 (93)	9.80 (56)
		Sle	13.40 (10)	8.75 (12)
	RS (0.029)	Wrs	10.00 (13)	7.80 (5)
		Crs	10.81 (94)	9.84 (56)
		Srs	12.45 (11)	9.67 (9)
Picture Arr.	n.s.			
Block Design	n.s.			
Object Assembly	RV (0.023)	Wrv	12.57 (7)	8.78 (9)
		Crv	11.53 (97)	9.95 (58)
		Srv	12.86 (14)	13.00 (3)
	LE (0.029)	Wle	11.60 (15)	11.50 (2)
		Cle	11.53 (93)	9.98 (56)
		Sle	14.00 (10)	9.42 (12)
	RS (0.059)	Wrs	10.54 (13)	10.20 (5)
		Crs	11.79 (94)	9.80 (56)
		Srs	12.82 (11)	10.56 (9)
Coding	n.s.			

TABLE 7-23
INTERACTION OF FIELD DEPENDENCE WITH CAT DIVISIONS: LEVEL OF SIGNIFICANCE AND WISC-R SCORES

WISC-R SUB-TEST	CAT DIVISION (P=X.XX)		WISC-R SCORES BY FIELD DEPENDENCE QUARTILE (Q)							
			Q1	(N)	Q2	(N)	Q3	(N)	Q4	(N)
Info	n.s.									
Sim	Sp	Wsp	10.00	(2)	9.00	(2)	12.67	(6)	10.75	(8)
	(0.041)	Csp	9.46	(41)	9.46	(46)	10.07	(29)	10.37	(35)
		Ssp	7.86	(7)	10.00	(7)	11.00	(3)	7.50	(1)
Arith	n.s.									
Voc	n.s.									
Comp	RC	Wrc	10.00	(5)	13.00	(3)	9.67	(3)	8.00	(6)
	(0.056)	Crc	9.39	(41)	10.04	(46)	10.29	(31)	9.75	(32)
		Src	10.50	(4)	10.50	(6)	10.25	(4)	10.14	(7)
Dg Sp	n.s.									
PC	RS	Wrs	6.67	(6)	9.00	(6)	13.00	(3)	12.00	(3)
	(0.003)	Crs	9.47	(40)	10.40	(43)	10.71	(31)	11.36	(36)
		Srs	12.00	(4)	11.00	(6)	11.25	(4)	10.83	(6)
PA	RS	Wrs	9.17	(6)	10.50	(6)	12.00	(3)	10.33	(3)
	(0.029)	Crs	10.02	(40)	11.40	(43)	11.06	(31)	11.42	(36)
		Srs	14.00	(4)	10.17	(6)	14.00	(4)	12.50	(6)
BD	MC	Wmc	8.00	(3)	10.75	(4)	14.67	(3)	12.50	(10)
	(0.003)	Cmc	8.98	(42)	1[illegible].40	(47)	10.40	(30)	13.21	(33)
		Smc	10.40	(5)	11.75	(4)	11.60	(5)	9.50	(2)
	MCA	Wmca	7.80	(5)	9.67	(6)	15.00	(1)	11.80	(5)
	(0.047)	Cmca	9.24	(42)	10.59	(41)	10.56	(34)	13.06	(36)
		Smca	8.67	(3)	10.88	(8)	13.33	(3)	12.75	(4)
	RS	Wrs	8.00	(4)	11.33	(3)	12.00	(3)	13.67	(3)
	(0.002)	Crs	9.89	(18)	10.64	(25)	10.18	(22)	12.97	(29)
		Srs	12.00	(1)	9.67	(3)	15.00	(2)	10.00	(5)
OA	MC	Wmc	11.33	(3)	10.00	(4)	10.67	(3)	13.10	(10)
	(0.053)	Cmc	9.43	(42)	10.66	(47)	11.23	(30)	13.24	(33)
		Smc	10.80	(5)	9.50	(4)	13.80	(5)	10.50	(2)
Cd	RV	Wrv	10.78	(9)	10.67	(3)	9.50	(3)	6.00	(2)
	(0.029)	Crv	10.91	(35)	9.77	(47)	10.00	(33)	10.70	(40)
		Srv	10.00	(6)	11.00	(5)	10.00	(3)	6.33	(3)

TABLE 7-24

GROUPS: READING VOCABULARY, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: INFORMATION

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	115.252	6	19.209	4.447	0.000
Read Voc	14.554	2	7.277	1.685	0.189
Field Dep	49.863	3	16.621	3.848	0.011
Sex	16.880	1	16.880	3.908	0.050
2-way Interactions	34.730	11	3.157	0.731	0.708
Read Voc-Field Dep	25.118	6	4.186	0.969	0.448
Read Voc-Sex	0.570	2	0.285	0.066	0.936
Field Dep-Sex	2.179	3	0.726	0.168	0.918
3-way Interactions	4.166	2	2.083	0.482	0.618
Read Voc-Field Dep-Sex	4.166	2	2.083	0.482	0.618
Explained	154.147	19	8.113	1.878	0.019
Residual	725.597	168	4.319		
Total	879.745	187	4.705		

TABLE 7-25

GROUPS: READING VOCABULARY, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: CODING

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	177,079	[illegible]	29.513	5.600	0.000
Read Voc	9.780	2	4.890	0.928	0.397
Field Dep	20.475	3	6.825	1.295	0.278
Sex	141.761	1	141.761	29.523	0.000
2-way Interactions	99.698	11	9.063	1.720	0.073
Read Voc-Field Dep	76.330	6	12.722	2.414	0.029
Read Voc-Sex	0.101	2	0.050	0.010	0.991
Field Dep-Sex	9.696	3	3.232	0.607	0.607
3-way Interactions	3.053	2	1.526	0.290	0.749
Read Voc-Field Dep-Sex	3.053	2	1.526	0.290	0.749
Explained	279.829	19	14.728	2.795	0.000
Residual	885.336	168	5.270		
Total	1165.165	187	6.231		

TABLE 7-26

GROUPS: READING COMPREHENSION, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: INFORMATION

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	120.086	6	20.014	4.777	0.000
Read Comp	19.388	2	9.694	2.314	0.102
Field Dep	50.080	3	16.693	3.984	0.009
Sex	16.696	1	16.696	3.985	0.048
2-way Interactions	49.403	11	4.491	1.072	0.387
Read Comp-Field Dep	25.068	6	4.178	0.997	0.429
Read Comp-Sex	22.598	2	11.299	2.697	0.070
Field Dep-Sex	2.002	3	0.667	0.159	0.924
3-way Interactions	10.581	3	3.527	0.842	0.473
Read Comp-Field Dep-Sex	10.581	3	3.527	0.842	0.473
Explained	180.070	20	9.003	2.149	0.473
Residual	699.675	167	4.190		
Total	879.745	187	4.705		

TABLE 7-27

GROUPS: READING COMPREHENSION, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: SIMILARITIES

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	80.376	6	13.396	2.518	0.023
Read Comp	25.678	2	12.839	2.414	0.093
Field Dep	53.746	3	17.915	3.368	0.020
Sex	5.366	1	5.366	1.009	0.317
2-way Interactions	101.009	11	9.183	1.726	0.071
Read Comp-Field Dep	38.426	6	6.404	1.204	0.307
Read Comp-Sex	13.770	2	6.885	1.284	0.277
Field Dep-Sex	41.504	3	13.835	2.601	0.054
3-way Interactions	20.862	3	6.954	1.307	0.274
Read Comp-Field Dep-Sex	20.862	3	6.954	1.307	0.274
Explained	202.246	20	10.112	1.901	0.015
Residual	888.280	167	5.319		
Total	1090.527	187	5.832		

TABLE 7-28

GROUPS: READING COMPREHENSION, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: COMPREHENSION

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	31.871	6	5.312	1.327	0.248
Read Comp	3.978	2	1.989	0.497	0.609
Field Dep	22.781	3	7.594	1.898	0.132
Sex	4.793	1	4.793	1.198	0.276
2-way Interactions	67.633	11	6.148	1.536	0.123
Read Comp-Field Dep	50.422	6	8.404	2.100	0.056
Read Comp-Sex	23.467	2	11.733	2.932	0.056
Field Dep-Sex	3.463	3	1.154	0.288	0.056
3-way Interactions	9.291	3	3.097	0.774	0.510
Read Comp-Field Dep-Sex	9.291	3	3.097	0.774	0.510
Explained	108.794	20	5.440	1.359	0.149
Residual	668.285	167	4.002		
Total	777.080	187	4.156		

TABLE 7-29

GROUPS: READING COMPREHENSION, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: PICTURE COMPLETION

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	153.006	6	25.501	5.547	0.000
Read Comp	17.780	2	8.890	1.585	0.208
Field Dep	69.003	3	23.001	4.101	0.008
Sex	29.043	1	29.043	5.178	0.024
2-way Interactions	60.792	11	5.527	0.985	0.462
Read Comp-Field Dep	41.908	6	6.985	1.245	0.286
Read Comp-Sex	2.573	2	1.286	0.229	0.795
Field Dep-Sex	23.239	3	7.748	1.381	0.250
3-way Interactions	13.500	3	4.500	0.802	0.494
Read Comp-Field Dep-Sex	13.500	3	4.500	0.802	0.494
Explained	227.299	20	11.365	2.026	0.008
Residual	936.659	167	5.609		
Total	1163.957	187	6.224		

TABLE 7-30

GROUPS: READING COMPREHENSION, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: OBJECT ASSEMBLY

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	388.344	6	64.724	10.583	0.000
Read Comp	5.901	2	2.950	0.482	0.618
Field Dep	231.831	3	77.277	12.635	0.008
Sex	45.575	1	45.575	7.452	0.007
2-way Interactions	23.3412	11	2.122	0.347	0.973
Read Comp-Field Dep	9.266	6	1.544	0.253	0.958
Read Comp-Sex	2.497	2	1.248	0.204	0.816
Field Dep-Sex	9.639	3	3.213	0.525	0.665
3-way Interactions	35.054	3	11.685	1.911	0.130
Read Comp-Field Dep-Sex	35.054	3	11.685	1.911	0.130
Explained	446.739	20	22.337	3.652	0.000
Residual	1021.362	167	6.116		
Total	1468.101	187	7.851		

TABLE 7-31

GROUPS: READING COMPREHENSION, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: CODING

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	174.004	6	29.001	5.257	0.000
Read Comp	6.706	2	3.353	0.608	0.546
Field Dep	18.427	3	6.142	1.113	0.345
Sex	142.502	1	142.502	25.831	0.000
2-way Interactions	56.660	11	5.151	0.934	0.510
Read Comp-Field Dep	13.017	6	2.170	0.393	0.883
Read Comp-Sex	24.025	2	12.013	2.178	0.117
Field Dep-Sex	16.924	3	5.641	1.023	0.384
3-way Interactions	13.222	3	4.407	0.799	0.496
Read Comp-Field Dep-Sex	13.222	3	4.407	0.799	0.496
Explained	243.886	20	12.194	2.210	0.003
Residual	921.279	167	5.517		
Total	1165.165	187	6.231		

TABLE 7-32

GROUPS: READING COMPREHENSION, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: OBJECT ASSEMBLY

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	388.344	6	64.724	10.583	0.000
Read Comp	5.901	2	2.950	0.482	0.618
Field Dep	231.831	3	77.277	12.635	0.000
Sex	45.575	1	45.575	7.452	0.007
2-way Interactions	23.341	11	2.122	0.347	0.973
Read Comp-Field Dep	9.266	6	1.544	0.253	0.958
Read Comp-Sex	2.497	2	1.248	0.204	0.816
Field Dep-Sex	9.639	3	3.213	0.525	0.665
3-way Interactions	35.054	3	11.685	1.911	0.130
Read Comp-Field Dep-Sex	35.054	3	11.685	1.911	0.130
Explained	446.739	20	22.337	3.652	0.000
Residual	1021.362	167	6.116		
Total	1368.101	187	7.851		

TABLE 7-33

GROUPS: READING COMPREHENSION, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: CODING

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	174.004	6	29.001	5.257	0.000
Read Comp	6.706	2	3.353	0.608	0.546
Field Dep	18.427	3	6.142	1.113	0.345
Sex	142.502	1	142.502	25.831	0.000
2-way Interactions	56.660	11	5.151	0.934	0.510
Read Comp-Field Dep	13.017	6	2.170	0.393	0.883
Read Comp-Sex	24.025	2	12.013	2.178	0.117
Field Dep-Sex	16.924	3	5.641	1.023	0.384
3-way Interactions	13.222	3	4.407	0.799	0.496
Read Comp-Field Dep-Sex	13.222	3	4.407	0.799	0.496
Explained	243.886	20	12.194	2.210	0.003
Residual	921.279	167	5.517		
Total	1165.165	187	6.231		

TABLE 7-34

GROUPS: SPELLING, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: INFORMATION

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	113.324	6	18.887	4.884	0.000
Spell	12.626	2	6.313	1.632	0.199
Field Dep	50.269	3	16.756	4.333	0.006
Sex	26.063	1	26.063	6.739	0.010
2-way Interactions	62.875	11	5.716	1.478	0.144
Spell-Field Dep	44.024	6	7.337	1.897	0.084
Spell-Sex	23.447	2	11.723	3.031	0.051
Field Dep-Sex	5.594	3	1.865	0.482	0.695
3-way Interactions	69.300	6	11.550	2.987	0.009
Spell-Field Dep-Sex	69.300	6	11.550	2.987	0.009
Explained	245.500	23	10.674	2.760	0.000
Residual	634.245	164	3.867		
Total	879.745	187	4.705		

TABLE 7-35

GROUPS: SPELLING, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: SIMILARITIES

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	76.691	6	13.115	2.535	0.023
Spell	23.993	2	11.997	2.319	0.102
Field Dep	38.777	3	12.926	2.499	0.061
Sex	3.574	1	3.574	0.691	0.407
2-way Interactions	132.699	11	12.064	2.332	0.011
Spell-Field Dep	69.884	6	11.674	2.252	0.041
Spell-Sex	25.403	2	12.701	2.455	0.089
Field Dep-Sex	48.837	3	16.279	3.147	0.027
3-way Interactions	30.789	6	5.131	0.992	0.433
Spell-Field Dep-Sex	30.789	6	5.131	0.992	0.433
Explained	242.179	23	10.530	2.036	0.006
Residual	848.347	164	5.173		
Total	1090.527	187	5.832		

TABLE 7-36

GROUPS: SPELLING, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: VOCABULARY

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	14.650	6	2.442	0.670	0.674
Spell	4.102	2	2.051	0.563	0.671
Field Dep	2.857	3	0.952	0.261	0.853
Sex	2.549	1	2.549	0.699	0.404
2-way Interactions	52.129	11	4.739	1.300	0.228
Spell-Field Dep	35.490	6	5.915	1.623	0.144
Spell-Sex	22.240	2	11.120	3.051	0.050
Field Dep-Sex	6.507	3	2.169	0.595	0.619
3-way Interactions	25.840	6	4.307	1.182	0.319
Spell-Field Dep-Sex	25.840	6	4.307	1.182	0.319
Explained	92.619	23	4.027	1.105	0.345
Residual	597.738	164	3.645		
Total	690.356	187	3.692		

TABLE 7-37

GROUPS: SPELLING, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: PICTURE COMPLETION

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	136.919	6	22.820	3.834	0.001
Spell	1.693	2	0.847	0.142	0.868
Field Dep	73.391	3	24.464	4.110	0.008
Sex	28.413	1	28.413	4.773	0.030
2-way Interactions	40.392	11	3.672	0.617	0.813
Spell-Field Dep	14.248	6	2.375	0.399	0.879
Spell-Sex	12.538	2	6.269	1.053	0.351
Field Dep-Sex	13.346	3	4.449	0.747	0.525
3-way Interactions	10.403	6	1.734	0.291	0.940
Spell-Field Dep-Sex	10.403	6	1.734	0.291	0.940
Explained	187.714	23	8.161	1.371	0.132
Residual	976.243	164	5.953		
Total	1163.957	187	6.224		

TABLE 7-38

GROUPS: SPELLING, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: OBJECT ASSEMBLY

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	387.319	6	64.563	10.615	0.000
Spell	4.876	2	2.438	0.401	0.870
Field Dep	235.210	3	78.403	12.893	0.000
Sex	49.059	1	49.059	8.067	0.005
2-way Interactions	34.768	11	3.161	0.520	0.888
Spell-Field Dep	17.296	6	2.883	0.474	0.827
Spell-Sex	8.948	2	4.474	0.736	0.481
Field Dep-Sex	11.694	3	3.898	0.641	0.590
3-way Interactions	48.694	6	8.116	1.335	0.245
Spell-Field Dep-Sex	48.694	6	8.116	1.335	0.245
Explained	470.781	23	20.469	3.366	0.000
Residual	997.320	164	6.081		
Total	1468.101	187	7.851		

TABLE 7-39

GROUPS: SPELLING, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: CODING

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	175.946	6	29.324	5.087	0.000
Spell	8.648	2	4.324	0.750	0.474
Field Dep	15.812	3	5.271	0.914	0.435
Sex	147.714	1	147.714	25.623	0.000
2-way Interactions	35.043	11	3.186	0.553	0.864
Spell-Field Dep	10.353	6	1.725	0.299	0.937
Spell-Sex	3.829	2	1.915	0.332	0.718
Field Dep-Sex	16.920	3	5.640	0.978	0.404
3-way Interactions	8.732	6	1.455	0.252	0.958
Spell-Field Dep-Sex	8.732	6	1.455	0.252	0.958
Explained	219.721	23	9.553	1.657	0.038
Residual	945.444	164	5.765		
Total	1165.165	187	6.231		

TABLE 7-40

GROUPS: LANGUAGE MECHANICS, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: INFORMATION

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	108.541	6	18.090	4.258	0.000
Lang Mech	7.843	2	3.921	0.923	0.399
Field Dep	56.357	3	18.786	4.422	0.005
Sex	24.147	1	24.147	5.684	0.018
2-way Interactions	52.829	11	4.803	1.130	0.341
Lang Mech-Field Dep	44.721	6	7.453	1.754	0.111
Lang Mech-Sex	6.301	2	3.151	0.742	0.478
Field Dep-Sex	6.161	3	2.054	0.483	0.694
3-way Interactions	4.631	2	2.315	0.545	0.581
Lang Mech-Field Dep-Sex	4.631	2	2.315	0.545	0.581
Explained	166.000	19	8.737	2.056	0.008
Residual	713.744	168	4.248		
Total	879.745	187	4.705		

TABLE 7-41

GROUPS: LANGUAGE MECHANICS, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: SIMILARITIES

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	59.764	6	9.961	1.737	0.115
Lang Mech	5.066	2	2.533	0.442	0.644
Field Dep	53.802	3	17.934	3.127	0.027
Sex	2.501	1	2.501	0.436	0.510
2-way Interactions	66.170	11	6.015	1.049	0.406
Lang Mech-Field Dep	4.036	6	0.673	0.117	0.994
Lang Mech-Sex	7.361	2	3.680	0.642	0.528
Field Dep-Sex	45.647	3	15.216	2.653	0.050
3-way Interactions	1.040	2	0.502	0.091	0.913
Lang Mech-Field Dep-Sex	1.040	2	0.502	0.091	0.913
Explained	126.974	19	6.683	1.165	0.293
Residual	963.552	168	5.735		
Total	1090.527	187	5.832		

TABLE 7-42

GROUPS: LANGUAGE MECHANICS, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: ARITHMETIC

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	36.020	6	6.003	1.145	0.339
Lang Mech	0.502	2	0.251	0.048	0.953
Field Dep	17.809	3	5.936	1.132	0.338
Sex	9.855	1	9.855	1.879	0.172
2-way Interactions	58.746	11	5.341	1.018	0.432
Lang Mech-Field Dep	25.918	6	4.320	0.824	0.553
Lang Mech-Sex	20.361	2	10.181	1.941	0.147
Field Dep-Sex	42.124	3	14.041	2.677	0.049
3-way Interactions	4.692	2	2.346	0.447	0.640
Lang Mech-Field Dep-Sex	4.692	2	2.346	0.447	0.640
Explained	99.457	19	5.235	0.998	0.466
Residual	881.203	168	5.245		
Total	980.660	187	5.244		

TABLE 7-43

GROUPS: LANGUAGE MECHANICS, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: PICTURE COMPLETION

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	137.817	6	22.969	4.192	0.001
Lang Mech	2.591	2	1.295	0.236	0.790
Field Dep	70.189	3	23.396	4.270	0.006
Sex	28.150	1	28.150	5.138	0.025
2-way Interactions	91.329	11	8.303	1.515	0.130
Lang Mech-Field Dep	60.046	6	10.008	1.827	0.097
Lang Mech-Sex	28.496	2	14.248	2.601	0.077
Field Dep-Sex	20.370	3	6.790	1.239	0.297
3-way Interactions	14.367	2	7.183	1.311	0.270
Lang Mech-Field Dep-Sex	14.367	2	7.183	1.311	0.270
Explained	243.512	19	12.816	2.339	0.002
Residual	920.445	168	5.479		
Total	1163.957	187	6.224		

TABLE 7-44

GROUPS: LANGUAGE MECHANICS, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: BLOCK DESIGN

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	356.229	6	59.371	10.553	0.000
Lang Mech	4.041	2	2.021	0.359	0.699
Field Dep	322.932	3	107.644	19.134	0.000
Sex	0.211	1	0.211	0.038	0.847
2-way Interactions	69.154	11	6.287	1.117	0.350
Lang Mech-Field Dep	25.428	6	4.238	0.753	0.608
Lang Mech-Sex	8.072	2	4.036	0.717	0.490
Field Dep-Sex	31.913	3	10.638	1.891	0.133
3-way Interactions	12.079	2	6.039	1.074	0.344
Lang Mech-Field Dep-Sex	12.079	2	6.039	1.074	0.344
Explained	437.462	19	23.024	4.093	0.000
Residual	945.155	168	5.626		
Total	1382.617	187	7.394		

TABLE 7-45

GROUPS: LANGUAGE MECHANICS, FIELD DEPENDENCE, & SEX WISC-R VARIABLE: OBJECT ASSEMBLY

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	390.811	6	65.135	10.831	0.000
Lang Mech	48.367	2	4.184	0.696	0.500
Field Dep	242.018	3	80.673	13.415	0.000
Sex	53.385	1	53.385	8.877	0.003
2-way Interactions	53.322	11	4.847	0.806	0.634
Lang Mech-Field Dep	37.018	6	6.169	1.026	0.410
Lang Mech-Sex	8.583	2	4.292	0.714	0.491
Field Dep-Sex	23.575	3	7.858	1.307	0.274
3-way Interactions	13.701	2	6.850	1.139	0.323
Lang Mech-Field Dep-Sex	13.701	2	6.850	1.139	0.323
Explained	457.833	19	24.096	4.007	0.000
Residual	1010.268	168	6.013		
Total	1468.101	187	7.851		

TABLE 7-46

GROUPS: LANGUAGE MECHANICS, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: CODING

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	181.942	6	30.324	5.864	0.000
Lang Mech	14.643	2	7.322	1.416	0.246
Field Dep	22.629	3	7.543	1.459	0.228
Sex	138.765	1	138.765	26.835	0.000
2-way Interactions	93.255	11	8.478	1.639	0.092
Lang Mech-Field Dep	46.146	6	7.691	1.487	0.185
Lang Mech-Sex	15.483	2	7.741	1.497	0.227
Field Dep-Sex	33.033	3	11.619	2.129	0.098
3-way Interactions	21.237	2	10.619	2.053	0.131
Lang Mech-Field Dep-Sex	21.237	2	10.619	2.053	0.131
Explained	269.433	19	15.602	3.017	0.000
Residual	868.732	168	5.171		
Total	1165.165	187	6.231		

TABLE 7-47

GROUPS: LANGUAGE EXPRESSION, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: INFORMATION

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	107.275	6	17.879	4.063	0.001
Lang Expr	6.577	2	3.288	0.747	0.475
Field Dep	52.925	3	17.642	4.009	0.009
Sex	21.638	1	21.638	4.917	0.028
2-way Interactions	21.673	11	1.970	0.448	0.932
Lang Expr-Field Dep	14.718	6	2.453	0.557	0.764
Lang Expr-Sex	2.330	2	1.165	0.265	0.768
Field Dep-Sex	7.362	3	2.454	0.558	0.644
3-way Interactions	15.862	3	5.287	1.201	0.311
Lang Expr-Field Dep-Sex	15.862	3	5.287	1.201	0.311
Explained	144.809	20	7.240	1.645	0.048
Residual	734.936	167	4.401		
Total	879.745	187	4.705		

TABLE 7-48

GROUPS: LANGUAGE EXPRESSION, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: SIMILARITIES

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	57.979	6	9.663	1.721	0.119
Lang Expr	3.281	2	1.641	0.292	0.747
Field Dep	55.340	3	18.447	3.285	0.022
Sex	2.281	1	2.281	0.406	0.525
2-way Interactions	75.866	11	6.897	1.228	0.272
Lang Expr-Field Dep	21.863	6	3.644	0.649	0.691
Lang Expr-Sex	1.953	2	0.976	0.174	0.841
Field Dep-Sex	50.306	3	16.769	2.986	0.033
3-way Interactions	18.820	3	6.273	1.117	0.344
Lang Expr-Field Dep-Sex	18.820	3	6.273	1.117	0.344
Explained	152.665	20	7.633	1.359	0.150
Residual	937.862	167	5.616		
Total	1090.527	187	5.832		

TABLE 7-49

GROURS: LANGUAGE EXPRESSION, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: BLOCK DESIGN

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	356.506	6	60.918	10.595	0.000
Lang Expr	13.318	2	6.659	1.158	0.317
Field Dep	320.013	3	106.671	18.553	0.000
Sex	0.022	1	0.022	0.004	0.951
2-way Interactions	47.810	11	4.346	0.756	0.683
Lang Expr-Field Dep	5.528	6	0.921	0.160	0.987
Lang Expr-Sex	13.382	2	6.691	1.164	0.315
Field Dep-Sex	34.189	3	11.396	1.982	0.119
3-way Interactions	9.138	3	3.046	0.530	0.662
Lang Expr-Field Dep-Sex	9.138	3	3.046	0.530	0.662
Explained	422.454	20	21.123	3.674	0.000
Residual	960.163	167	5.749		
Total	1382.617	187	7.394		

TABLE 7-50

GROUPS: LANGUAGE EXPRESSION, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: OBJECT ASSEMBLY

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	402.698	6	67.116	11.807	0.000
Lang Expr	20.255	2	10.127	1.782	0.172
Field Dep	243.160	3	81.053	14.258	0.000
Sex	56.155	1	56.155	9.878	0.002
2-way Interactions	97.376	11	8.852	1.557	0.118
Lang Expr-Field Dep	35.415	6	5.902	1.038	0.402
Lang Expr-Sex	40.983	2	20.491	3.605	0.029
Field Dep-Sex	10.230	3	3.410	0.600	0.616
3-way Interactions	18.688	3	6.229	1.096	0.353
Lang Expr-Field Dep-Sex	18.688	3	6.229	1.096	0.353
Explained	518.763	20	25.938	4.563	0.000
Residual	949.339	167	5.685		
Total	1468.101	187	7.851		

TABLE 7-51

GROUPS: LANGUAGE EXPRESSION, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: CODING

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	176.548	6	29.425	5.287	0.000
Lang Expr	9.249	2	4.625	0.831	0.437
Field Dep	17.499	3	5.816	1.045	0.374
Sex	150.120	1	150.120	26.974	0.000
2-way Interactions	53.334	11	4.849	0.871	0.570
Lang Expr-Field Dep	25.978	6	4.330	0.778	0.588
Lang Expr-Sex	7.777	2	3.888	0.699	0.499
Field Dep-Sex	7.713	3	2.571	0.462	0.709
3-way Interactions	5.856	3	1.952	0.351	0.789
Lang Expr-Field Dep-Sex	5.856	3	1.952	0.351	0.789
Explained	235.739	20	11.787	2.118	0.005
Residual	929.426	167	5.565		
Total	1165.165	187	6.231		

TABLE 7-52

GROUPS: MATHEMATICS COMPUTATION, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: PICTURE COMPLETION

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	148.796	6	24.799	4.321	0.000
Math Comp	13.570	2	6.785	1.182	0.309
Field Dep	62.630	3	20.877	3.638	0.014
Sex	28.667	1	28.667	4.995	0.027
2-way Interactions	66.108	11	6.010	1.047	0.408
Math Comp-Field Dep	45.117	6	7.520	1.310	0.255
Math Comp-Sex	3.344	2	1.672	0.291	0.748
Field Dep-Sex	20.377	3	6.792	1.183	0.318
3-way Interactions	7.823	6	1.304	0.227	0.967
Math Comp-Field Dep-Sex	7.823	6	1.304	0.227	0.967
Explained	222.727	23	9.684	1.687	0.033
Residual	941.231	164	5.739		
Total	1163.957	187	6.224		

TABLE 7-53

GROUPS: MATHEMATICS COMPUTATION, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: BLOCK DESIGN

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	359.034	6	59.839	11.615	0.000
Math Comp	6.846	2	3.423	0.664	0.516
Field Dep	303.363	3	101.121	19.627	0.000
Sex	0.061	1	0.061	0.012	0.914
2-way Interactions	169.605	11	15.419	2.993	0.001
Math Comp-Field Dep	105.261	6	17.543	3.405	0.003
Math Comp-Sex	30.120	2	15.060	2.923	0.057
Field Dep-Sex	58.596	3	19.532	3.791	0.012
3-way Interactions	9.014	6	1.502	0.292	0.940
Math Comp-Field Dep-Sex	9.014	6	1.502	0.292	0.940
Explained	537.654	23	23.376	4.537	0.000
Residual	844.963	164	5.152		
Total	1382.617	187	7.394		

TABLE 7-54

GROUPS: MATHEMATICS COMPUTATION, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: OBJECT ASSEMBLY

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	385.811	6	64.302	11.007	0.000
Math Comp	3.367	2	1.684	0.288	0.750
Field Dep	224.676	3	74.892	12.820	0.000
Sex	49.759	1	49.759	8.518	0.004
2-way Interactions	86.205	11	7.837	1.341	0.206
Math Comp-Field Dep	74.596	6	12.433	2.128	0.053
Math Comp-Sex	6.185	2	3.092	0.529	0.590
Field Dep-Sex	21.996	3	7.266	1.244	0.296
3-way Interactions	38.005	6	6.334	1.084	0.374
Math Comp-Field Dep-Sex	38.005	6	6.334	1.084	0.374
Explained	510.020	23	222.175	3.796	0.000
Residual	958.081	164	5.842		
Total	1468.101	187	7.851		

TABLE 7-55

GROUPS: MATHEMATICS COMPUTATION, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: CODING

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	178.446	6	29.741	5.457	0.000
Math Comp	11.148	2	5.574	1.023	0.362
Field Dep	21.541	3	7.180	1.317	0.271
Sex	148.372	1	148.372	27.222	0.000
2-way Interactions	72.046	11	6.550	1.202	0.290
Math Comp-Field Dep	39.353	6	6.559	1.203	0.307
Math Comp-Sex	2.104	2	1.052	0.193	0.825
Field Dep-Sex	31.377	3	10.459	1.919	0.129
3-way Interactions	20.794	6	3.466	0.636	0.701
Math Comp-Field Dep-Sex	20.794	6	3.466	0.636	0.701
Explained	271.286	23	11.795	2.164	0.003
Residual	893.879	164	5.450		
Total	1165.165	187	6.231		

TABLE 7-56

GROUPS: MATHEMATICS CONCEPTS & APPLICATIONS, FIELD DEPENDENCE, & SEX -- WISC-R VARIABLE: INFORMATION

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	105.437	6	17.573	4.017	0.001
Math C & A	4.739	2	2.370	0.542	0.583
Field Dep	51.965	3	17.322	3.960	0.009
Sex	25.026	1	25.026	5.721	0.018
2-way Interactions	30.626	11	2.784	0.636	0.796
Math C & A-Field Dep	26.381	6	4.397	1.005	0.424
Math C & A-Sex	2.464	2	1.232	0.283	0.755
Field Dep-Sex	5.565	3	1.855	0.424	0.736
3-way Interactions	NOT DONE				
Math C & A-Field Dep-Sex	NOT DONE				
Explained	136.063	17	8.004	1.830	0.028
Residual	743.682	170	4.375		
Total	879.745	187	4.705		

TABLE 7-57

GROUPS: MATHEMATICS CONCEPTS & APPLICATIONS, FIELD DEPENDENCE, & SEX -- WISC-R VARIABLE: SIMILARITIES

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	67.615	6	11.269	2.008	0.067
Math C & A	12.917	2	6.458	1.151	0.319
Field Dep	47.420	3	15.807	2.816	0.041
Sex	0.549	1	0.549	0.098	0.755
2-way Interactions	68.703	11	6.246	1.113	0.354
Math C & A-Field Dep	12.166	6	2.028	0.361	0.903
Math C & A-Sex	5.577	2	2.789	0.497	0.609
Field Dep-Sex	48.382	3	16.127	2.873	0.038
3-way Interactions	NOT DONE				
Math C & A-Field Dep-Sex	NOT DONE				
Explained	136.318	17	8.019	1.429	0.128
Residual	954.209	170	5.832		
Total	879.745	187	4.705		

TABLE 7-58

GROUPS: MATHEMATICS CONCEPTS & APPLICATIONS, FIELD DEPENDENCE, & SEX -- WISC-R VARIABLE: BLOCK DESIGN

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	365.914	6	60.986	11.405	0.000
Math C & A	13.727	2	6.863	1.284	0.280
Field Dep	321.993	3	107.331	20.071	0.000
Sex	0.078	1	0.078	0.015	0.904
2-way Interactions	107.640	11	9.785	1.830	0.052
Math C & A-Field Dep	70.030	6	11.672	2.183	0.047
Math C & A-Sex	5.364	2	2.682	0.502	0.606
Field Dep-Sex	55.200	3	18.400	3.441	0.018
3-way Interactions	NOT DONE				
Math C & A-Field Dep-Sex	NOT DONE				
Explained	473.554	17	27.856	5.209	0.000
Residual	909.063	170	5.347		
Total	1382.617	187	7.394		

TABLE 7-59

GROUPS: MATHEMATICS CONCEPTS & APPLICATIONS, FIELD DEPENDENCE, & SEX -- WISC-R VARIABLE: OBJECT ASSEMBLY

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	382.856	6	63.806	10.462	0.000
Math C & A	0.413	2	0.206	0.034	0.967
Field Dep	235.371	3	78.457	12.863	0.000
Sex	49.503	1	49.503	8.116	0.005
2-way Interactions	48.475	11	4.398	0.721	0.717
Math C & A-Field Dep	23.491	6	3.915	0.642	0.697
Math C & A-Sex	8.137	2	4.066	0.667	0.515
Field Dep-Sex	11.478	3	3.826	0.627	0.598
3-way Interactions	NOT DONE				
Math C & A-Field Dep-Sex	NOT DONE				
Explained	432.231	17	25.367	4.159	0.000
Residual	1036.870	170	6.099		
Total	1468.101	187	7.851		

TABLE 7-60

GROUPS: MATHEMATICS CONCEPTS & APPLICATIONS, FIELD DEPENDENCE, & SEX -- WISC-R VARIABLE: CODING

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	173.537	6	28.923	5.180	0.000
Math C & A	6.238	2	3.119	0.559	0.573
Field Dep	15.514	3	5.171	0.926	0.429
Sex	123.324	1	123.324	22.088	0.000
2-way Interactions	42.482	11	3.862	0.690	0.745
Math C & A-Field Dep	18.605	6	3.101	0.555	0.765
Math C & A-Sex	2.413	2	1.206	0.216	0.806
Field Dep-Sex	25.422	3	8.474	1.518	0.212
3-way Interactions	NOT DONE				
Math C & A-Field Dep-Sex	NOT DONE				
Explained	216.019	17	12.707	2.276	0.004
Residual	949.146	170	5.583		
Total	1165.165	187	6.231		

TABLE 7-61

GROUPS: REFERENCE SKILLS, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: INFORMATION

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	104.521	6	17.420	4.053	0.001
Ref Skill	3.823	2	1.911	0.445	0.642
Field Dep	54.723	3	18.241	4.244	0.006
Sex	20.676	1	20.676	4.810	0.030
2-way Interactions	52.368	11	4.761	1.108	0.358
Ref Skill-Field Dep	29.070	6	4.845	1.127	0.349
Ref Skill-Sex	6.113	2	3.056	0.711	0.493
Field Dep-Sex	5.915	3	1.972	0.459	0.711
3-way Interactions	9.366	4	2.341	0.545	0.703
Ref Skill-Field Dep-Sex	9.366	4	2.341	0.545	0.703
Explained	166.255	21	7.917	1.842	0.018
Residual	713.490	166	4.298		
Total	879.745	187	4.705		

TABLE 7-62

GROUPS: REFERENCE SKILLS, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: SIMILARITIES

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	62.538	6	10.423	1.921	0.080
Ref Skill	7.840	2	3.920	0.723	0.487
Field Dep	53.579	3	17.860	3.292	0.022
Sex	2.318	1	2.318	0.427	0.514
2-way Interactions	98.022	11	8.911	1.643	0.091
Ref Skill-Field Dep	26.003	6	4.334	0.799	0.572
Ref Skill-Sex	28.332	2	14.166	2.611	0.076
Field Dep-Sex	63.529	3	21.176	3.903	0.010
3-way Interactions	29.379	4	7.345	1.354	0.252
Ref Skill-Field Dep-Sex	29.379	4	7.345	1.354	0.252
Explained	189.939	21	9.045	1.667	0.041
Residual	900.588	166	5.425		
Total	1090.527	187	5.832		

TABLE 7-63

GROUPS: REFERENCE SKILLS, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: DIGIT SPAN

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	46.178	6	7.696	1.409	0.214
Ref Skill	11.422	2	5.711	1.046	0.354
Field Dep	27.766	3	9.255	1.695	0.170
Sex	20.571	1	20.571	3.767	0.054
2-way Interactions	79.559	11	7.233	1.325	0.215
Ref Skill-Field Dep	45.362	6	7.560	1.385	0.215
Ref Skill-Sex	13.724	2	6.862	1.257	0.224
Field Dep-Sex	26.688	3	8.896	1.629	0.185
3-way Interactions	5.363	4	1.341	0.246	0.912
Ref Skill-Field Dep-Sex	5.363	4	1.341	0.246	0.912
Explained	131.100	21	6.243	1.437	0.309
Residual	906.453	166	5.461		
Total	1037.553	187	5.548		

TABLE 7-64

GROUPS: REFERENCE SKILLS, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: PICTURE COMPLETION

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	163.853	6	27.309	5.258	0.000
Ref Skill	28.627	2	14.313	2.756	0.066
Field Dep	61.230	3	20.410	3.930	0.010
Sex	34.331	1	34.331	6.610	0.011
2-way Interactions	133.489	11	12.135	2.336	0.011
Ref Skill-Field Dep	105.797	6	17.633	3.395	0.003
Ref Skill-Sex	37.606	2	18.803	3.620	0.029
Field Dep-Sex	16.092	3	5.364	1.033	0.380
3-way Interactions	4.421	4	1.105	0.213	0.931
Ref Skill-Field Dep-Sex	4.421	4	1.105	0.213	0.931
Explained	310.763	21	14.370	2.767	0.000
Residual	862.195	166	5.194		
Total	1163.957	187	6.224		

TABLE 7-65

GROUPS: REFERENCE SKILLS, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: BLOCK DESIGN

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	353.026	6	58.838	11.500	0.000
Ref Skill	0.838	2	0.419	0.082	0.921
Field Dep	315.058	3	105.019	20.527	0.000
Sex	0.183	1	0.183	0.036	0.850
2-way Interactions	159.065	11	14.460	2.826	0.002
Ref Skill-Field Dep	111.619	6	18.603	3.636	0.002
Ref Skill-Sex	0.179	2	0.090	0.018	0.983
Field Dep-Sex	36.799	3	12.266	2.398	0.070
3-way Interactions	21.249	4	5.312	1.038	0.389
Ref Skill-Field Dep-Sex	21.249	4	5.312	1.038	0.389
Explained	533.339	21	25.397	4.964	0.000
Residual	849.278	166	5.116		
Total	1382.617	187	7.394		

TABLE 7-66

GROUPS: REFERENCE SKILLS, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: OBJECT ASSEMBLY

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	394.603	6	65.767	11.061	0.000
Ref Skill	12.160	2	6.080	1.023	0.362
Field Dep	222.658	3	74.219	12.482	0.000
Sex	56.457	1	56.457	9.495	0.002
2-way Interactions	78.101	11	7.100	1.194	0.295
Ref Skill-Field Dep	54.357	6	9.060	1.524	0.173
Ref Skill-Sex	34.184	2	17.092	2.875	0.059
Field Dep-Sex	14.577	3	4.859	0.817	0.486
3-way Interactions	8.354	4	2.091	0.352	0.843
Ref Skill-Field Dep-Sex	8.354	4	2.091	0.352	0.843
Explained	481.068	21	22.908	3.853	0.000
Residual	987.033	166	5.946		
Total	1468.101	187	7.851		

TABLE 7-67

GROUPS: REFERENCE SKILLS, FIELD DEPENDENCE, & SEX
WISC-R VARIABLE: CODING

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	F RATIO
Main Effects	186.861	6	31.143	5.806	0.000
Ref Skill	19.563	2	9.781	1.823	0.165
Field Dep	18.266	3	6.089	1.135	0.337
Sex	150.136	1	150.136	27.988	0.000
2-way Interactions	60.985	11	5.544	1.034	0.419
Ref Skill-Field Dep	37.979	6	6.330	1.180	0.319
Ref Skill-Sex	3.593	2	1.796	0.335	0.716
Field Dep-Sex	19.446	3	6.482	1.208	0.308
3-way Interactions	26.855	4	6.714	1.252	0.291
Ref Skill-Field Dep-Sex	26.855	4	6.714	1.252	0.291
Explained	274.702	21	13.081	2.439	0.001
Residual	890.463	166	5.364		
Total	1165.165	187	6.231		

DISCUSSION - THE INTERACTIONS

This section examines perhaps the most interesting results of this research, but the results are complex and interwoven among many variables; hence, they are among the most difficult to summarize and to make meaningful. The examination begins with a look at the WISC-R subtests which most often enter into some relationship with some other element in the study.

The WISC-R subtests that are most influenced when significant main effects of field dependence result from analysis of variance are Information, Similarities, Picture Completion, Block Design, and Object Assembly. This list should provoke little surprise at this point in the reader's examination of this study, for these are the subtests which have often shown significant main effects when profiles for the various CAT divisions were developed. And, given the already noted interactions between sex and field dependence, it should not surprise the reader that some of the subtests most frequently showing significant main effects with sex are the same subtests that have shown interaction with field dependence. Information, Picture Completion, and Object Assembly are included on both lists. There are some exceptions. Block Design and Similarities drop out of the main effects with sex list, and Coding is added to the list. The same WISC-R subtests as show main effects with sex and field dependence also show interactions on sex by CAT divisions or field dependence by CAT division in the multiple analyses of variance.

Sex interacts at $\underline{p} \leq 0.05$ with Information and Vocabulary on CAT Spelling divisions; with Comprehension on Reading Comprehesion and Math Computation divisions; with Picture Completion on Language Expression and Reference Skills divisions; and on Object Assembly with Language Expression, Reading Vocabulary, and Reference Skills divisions. Field dependence interacts ($\underline{p} \leq 0.05$) with Similarities on Spelling; Comprehension on Reading Comprehension; Picture Completion on Reference Skills; Block Design on Math Computation, Math Concepts and Applications, and Reference Skills; Object Assembly on Math Computation; and Coding with Reading Vocabulary. Before examining the kinds of relations suggested in these combinations, it is perhaps germane to look at sex differences manifested in this study.

Girls score lower than boys on all three of the IQ scores, and the score differences are significant for each set of male-female IQ scores. On the Full Scale IQ the boys' mean is 101.3 compared to the girls' 97.77. The 3.53-point difference is significant at $\underline{p} \leq 0.005$. The Performance and Verbal Scales differ at the $\underline{p} \leq 0.025$ level. In discussing the small but consistent differences found between LD and normal children on subtest scatter, Kaufman suggests that a "selection bias" may be working, namely, that those doing psychoeducational assessments have a stereotyped notion that LD students with display greater scatter (1981, p. 523). It seems highly likely that the small, but significant, differences found here between male and female scores may also result from a "selection bias."

As a rule, girls, especially in the early grades, have better behavior, have greater language abilities, have better handwriting, and have a number of other "academic" and social skills which contribute to a better adjustment to classroom life than boys make. The better adjustment or apparent adjustment may serve to mask the learning deficits a girl has to the point that females may have to show greater ability deficits before being identified as in need of psychoeducational assessment. If such is the case, and there is every reason to believe that it is, then there is a selection bias operating: a girl will have to be functioning at a relatively lower level than most of the boys in her class before she is identified as a potential LD child and referred for assessment. The result would be that, in general, the girls included in this study will show greater ability deficits than do the boys. In view of this probable selection bias, it would seem unwise to suggest that the differences in male and female IQ or subtest scores found here are indicative of anything more significant than a selection bias. It is noted, however, that the female scores fall well within the Average classification, and it is assumed that the patterns within the girls' scores and differential patterns in male and female scores are meaningful, subject to the constraints of statistical significance and such other criteria as may bear. With these reservations noted, the interactions of the various subtests with sex may be examined.

It appears that the interactions involving sex may be clustered into four groups: memory, language, analysis, and synthesis. The memory group is suggested by the interaction of Spelling with Information and Vocabulary. On the Information subtest, the strong and weak spellers among both girls and boys as well as the average spellers of the boys all score about the same, but the mid-group of the girls scores low relative to the others. Vocabulary shows a different pattern. Female Vocabulary scores are essentially unaffected by spelling ability while the male Vocabulary scores decrease with increasing spelling abililty. The reader may recall that weak spellers also receive significantly higher scores on Similarities and Block Design, two tests associated with analysis and with field independence. There are two memory factors associated with all the tests mentioned: recall and recogition. Information, Vocabulary, and Similarities primarily demand recall; the CAT Spelling test can be accomplished through recognition. Other factors may be involved as well. The association of poor spelling and success on the Similarities and Block Design may suggest a successive vs. simultaneous processing component, and, possibly, differences in the tendency to perceive in terms of either units or relations in the SOI sense.

The language group is represented by the interactions of Reading Comprehension and Mathematics Computation with WISC-R Comprehension. The Mathematics Computation interaction is consistent with results throughout this research. There is a negative relationship between mathematical ability and linguistic ability for this group. When divided on the basis of success in Mathematics Computation, the girls show poorer scores than boys on Comprehension. The highest Comprehension mean for the girls is the Wmc group, but it is less than the lowest mean for the boys which is in the Smc group. The pattern of scores is, however, the same: the lowest scores on the Comprehension subtest for each sex are at the strong end of Mathematics Computation and the difference between high scores and low scores is approximately the same for both sexes. The usual list of abilities required for successful performance on the Comprehension subtest, common sense, cultural background, breadth of experience, and so on, would not seem to discriminate boys from girls in this study. There is no compelling reason to believe that either girls or boys would hold an advantage on any of the factors listed. It may well be that the differences in scores are, in large part, simply a factor of the "social studies" nature of many of the questions on the

Comprehension subtest. The generally lower ability level of the girls in the research group may be a factor as well. However, the influences of simultaneous and successive processing should not be overlooked as possible sources of variance.

The interaction between WISC-R Comprehension, sex, and the Reading Comprehension subtest is more difficult to unravel. Male scores on Comprehension increase as Reading Comprehnsion strength increases, as would be expected, but female scores on WISC-R Comprehension appear to decrease as Reading Comprehension scores increase. The word 'appear' is added here because the score trend may be specious as there are only three girls in the low Reading Comprehension group. There is, however, some data that would tend to support a real trend as opposed to the specious one. That support is based in the observation that, overall, the girls in the study (and in general) tend to be less field independent, and when the Comprehension scores are examined in the field dependence by Reading Comprehension equation, the higher scores for the weak reading group fall in the first two quartiles. It seems reasonable to treat the sex by Reading Comprehension interaction as a variation of the field dependence by Reading Comprehension interaction. That interaction will be treated next.

The weakest reader's, primarily boys (14 of 17 in the category), Comprehension scores decline with increasing field independence. If successive processing if an important factor in both expressive and receptive language skills, it can be argued that the lowest group of readers may, among other things, tend toward a preference for simultaneous processing, and as that tendency increases, as presumably it does as one becomes more field independent, the predisposition to process simultaneously may begin to interfere with the expressive language abilities required for success on the Comprehension subtest. The differences among the scores of the Crc group are relatively small and little should be made of the differences there. The strong reading group shows virtually no difference in scores as field independence increases. These observations can be interpreted within a conceptual structure suggested by Bloom-Feshback (1980). He suggested that field independence lies in differentiation of the right hemisphere, dual function of that hemisphere, and integrated function in highly differentiated individuals. Assuming then that field independence is a right-hemisphere function, it may be argued that the poor readers are less differentiated, and as greater demands are made on the right hemisphere, for example the reasoning tasks of the WISC-R Comprehension subtest, the appropriate integration does not take place and lower Comprehension scores result. The good readers, on the other hand, are differentiated and integrated and as a result are able to handle both the successive and simultaneous aspects of the task with facility. This analysis of the results obtained is admittedly speculative, but it has conceptual support in Bloom-Feshbach's research.

The set of interactions between Picture Completion scores and sex by Language Expression and sex by Reference Skills seem to share a common factor of analysis for essential and nonessential detail in both figural and written language. Field dependence and Reference skills also interact to influence Picture Completion scores. For males PC scores, Language Expression scores, and Reference Skills scores all increase together. The female scores are suspect here, again, because there are only two cases in the Wle group. Nevertheless, it appears that facility with figural stimuli interferes with the processing of language for this group of girls. The two girls showing the greatest negative discrepancy between their Total Battery score and their Language Expression scores averaged 11.50 on Picture Completion, 1.7 points greater than the Cle group and 2.75 points greater than the Sle group.

When girls' Picture Completion scores are compared with their Reference Skill scores, a different picture emerges. In this comparison, skills in visual discrimination are required for both tasks, and Picture Completion scores tend to increase with increasing competence in Reference Skills. While the Crs group has the highest mean score on PC, the difference between that group and the Srs females is not significant: 9.84 compared to 9.67. The male-female score differences are large. The boys' PC scores range from a low of 10.00 to a high of 12.45 while the girls' range is from 7.80 to 9.84. In part the discrepancy may be accounted for by the generally lower ability of the girls in the sample, but it appears that field *dependence* (or successive processing) plays a role in the lower overall range of the girls' scores and in the Picture Completion scores obtained by both girls and boys at all three levels of achievement on the Reference Skills subtest. A discussion of the role of the field dependence factor follows.

The lowest PC scores for the weak Reference Skills group cluster in the lowest two quartiles of field dependence. Among the Crs group, Picture Completion scores gradually increase with increasing field independence. There is no clear pattern among the Srs group with movement from field dependent to field independent; the high scores fall in the first and third quartiles. The Srs group does, however, receive the highest Picture Completion scores. The Srs group mean is 12.40 as compared to 9.39 for Wrs and 10.52 for Crs. It appears that a facility for analysis is increased in field independent students and that facility extends for some into verbal areas or, alternatively, into areas requiring the integration of verbal and nonverbal material. Whether the gains noted arise solely from increased facility with nonverbal material or some gain is also realized in the analysis of verbal or written material is important. Given the Picture Completion score pattern noted in the discussion of the sex by Language Expression interaction, it seems probable that analysis of both written and figural material is enhanced for field independent students. The Bloom-Feshback notion of differentiation and integration seems appropriate here too.

The synthesis grouping consists of the WISC-R Object Assembly subtest and the CAT Language Expression, Reading Vocabulary, and Reference Skills subtests. The Object Assembly, Language Expression, and Reference Skills Subtests all require the synthesis of new information from the elements presented in the problem. For the most part, the Object Assembly and Language Expression subtests require only that the identified elements be rearranged into a new and satisfactory gestalt. The Reference Skills subtests requires first analysis, as suggested in the previous discussion, and then the integration of the essential elements into a new gestalt, a new form. It is not entirely clear what Reading Vocabulary has in common with the other subtests. It may be that the graphemes call up gestalts, either visual for concrete words or conceptual for abstract words. Those gestalts are then evaluated on a match or mismatch basis, and a synthesis results when the desired meanings form an appropriate gestalt within the specified criteria. All of the tasks included here may involve, to some greater or lesser extent, the matching of the newly created gestalt--the restructured elements--with some internal, or internalized, criteria for gestalts of that class or category. It seems probable that one criterion is meaningfulness in terms of the individual's own experience.

For males Object Assembly scores increase with increasing ability in Language Expression and Reference Skills, but there is little change in OA scores as their skill in Reading Vocabulary improve. This result may reflect an underlying similarity of the Object Assembly and Reading Vocabulary subtests. That similarity may involve the matching of elements which have been previously identified or which are not embedded in a more complex stimulus field. All male groups receive relatively high scores on OA (10.54 to 14.00) for the three CAT divisions. On the same subtest, the girls' scores ranged from 8.78 to 13.00, but the pattern within the CAT divisions is quite different than that exhibited by the boys. Female Object Assembly scores increase dramatically as Reading Vocabulary improves. That pattern reverses itself when OA scores are related to Language Expression; although, the range is considerably reduced (2.08 scaled score points for LE as compared to 4.22 for RV). The OA scores in the sex by Reference Skills interaction are indeterminant; the higher scores are at Wrs and Srs, but these differ from the low Crs group by less than one scaled score point. The OA scores of the middle group for the three CAT subtests in this group are remarkably consistent. For mid-group males, the OA scores in the three CAT divisions are 11.53, 11.53, and 11.79, and for females they are 9.95, 9.98, and 9.80. An examination of the field independence profiles for each of the groups sheds some light on the problem of female scores.

When the OA scores in the field dependence by Reading Vocabulary interaction are examined, the following results are obtained. Of nine girls in the Wrv group, eight fall into the first two quartiles and one is in the third quartile; her score, 10.00, is greater than the mean scores of the girls in either the first or second quartiles. Of seven males in the Wrv group, four are in the first quartile, and their average score is 12; none fall into the second quartile; one is in the third quartile, and he scores 16 on the OA subtest; and three are in the fourth quartile with a mean score of 12. Three girls are in the Srv group, two in the first quartile with a mean score of 12.5 and one in the third quartile with a score of 14. Both males and females in the middle group manifest consistent increases in AO scores as field independence increases. The magnitude for each group is from about 9 to 13. These results suggest that girls who show low Reading Vocabulary scores relative to their Total Battery scores are field dependent and are likely to be deficient in gestalt recognition or, at least, deficient in the recognition of graphemic gestalts.

There are only two girls among the 17 students in the weak Language Expression group. Those girls are in the fourth quartile of field dependence, that is, they are highly field independent. Their mean OA score, 11.50, is comparable to that of the 15 boys in the Wle group. The boys' OA scores in the Wle group are, by ascending quartile, 11.25, 11.20, 13.50, and 11.50. The scores suggest that for this group the processing of figural gestalts is largely independent of language ability. A relative deficit in sequential processing may be a factor as well. An examination of the weak Language Expression WISC-R profile discussed under Hypothesis I shows low scores on the tasks requiring successive processing, including two out of three of the expressive language tasks. In the Cle group, OA scores consistently improve for both males and females as they become more field independent. The increase in AO scores is approximately that noted with Reading Vocabulary, i.e., in the 9 to 13 range. The 10 males in the Sle group are divided four in the lower two quartiles and six in the upper two; their OA scores increase with increasing field independence. Females cluster in the field dependent first and second quartiles. Ten of the twelve girls in the Sle group are in the first two quartiles and the mean AO score for the two quartiles is 9.1 This examination seems to show that differences in the scores of males and females in the sex by Language Expression interaction are in part reducible to differences in field dependence between the sexes. It also suggests that a primary factor for female success on the Language Expression subtest is the ability to effect a successive synthesis, that is, to process successively in language, and that that synthesis is largely independent of figural synthesis. It appears that males and females may achieve similar results on the Language Expression subtest but achieve those results through different cognitive processes.

The sex differences in the Object Assembly by Reference Skills interaction manifest an even greater influence of field dependence factors. Of the 18 students in the Wrs group, all five of the girls and seven of the 13 boys are in the first two quartiles. The girls' OA scores are slightly higher than the boys' scores for the field dependent group; the mean of the field dependent quartiles is 9.25. That mean compares with 12.83 for the six boys in the field independent quartiles. The Crs group shows the same range of score increase with increasing field independence as do the Language Expression and Reading Vocabulary subtests. In the Srs group the girls' scores again cluster in the field dependent quartiles at a rate of two-to-one, while the boys' scores cluster two-to-one in the third and fourth quartiles. Within each sex, however, the mean OA scores of the field dependent and field independent clusters of Srs do not differ with by more than a few tenths of a point. These observations suggest that while field independence, and presumably simultaneous processing, becomes relatively more influential on the Reference Skill task because of the increase in figural material, the factors of differentiation and integration continue to play a role. Field independence facilitates success on both the Reference Skills and the Object Assembly subtests. Sex differences in preference for successive and simultaneous processing seem to receive further support.

For the most part, the interactions between field dependence and the CAT subtests have been discussed in examining the sex by CAT subtest interactions. There are notable exceptions: the Block Design and Object Assembly interactions with Mathematics Computation, Block Design interactions with Mathematics Concepts and Applications, and the Coding interaction with Reading Vocabulary.

When the middle group of Mathematics Computation scores for both Block Design and Object Assembly are reviewed, the pattern previously noted again reveals itself: the WISC-R subtest scores increase from plus or minus 9 to plus or minus 13. There are further similarities between the two WISC-R subtest scores in the Mathematics Computation division. Most students in the Wmc group are in the two field independent quartiles, and, as would be expected, the more field independent groups receive higher scores on both the BD and OA subtests than do those groups in the field dependent quartiles. On Block Design the scores compare FI 13.00 to FD 9.57; for Object Assembly the comparison is FI 12.5 to FD 10.57. For the low mathematics group, field independence does not facilitate mathematics performance. In the strong mathematics group, the Block Design mean scores for both the field dependent and field independent group are the same, 11 scaled score points. The Object Assembly scores tend to increase by about one point in the transition from field dependent to field independent, but the mean score for both groups is 10.66. Male scores for both Block Design and Object Assembly for all three CAT levels are higher than female scores.

Mathematics Computation is clearly a task that requires sequential or successive processing. The persons who do not do well on this task tend to be field independent and, it is argued, have a predisposition to process simultaneously. It seems probable that the tendency to process simultaneously persists even when it is the inappropriate mode for a given problem. For reasons earlier reviewed (attention to detail, task-orientation, restructuring information to a task-appropriate form, etc.), the middle group benefits from increasing field independence. The superior mathematics group, it can be argued, tends to be highly differentiated and is not greatly influenced by the field dependence dimension, or put another way, the superior group is not constrained by an inflexible problem-solving repertoire and chooses a task-appropriate tactic. There is no indication in the results reviewed here of the role played by numerical or symbolic, in contrast to figural or verbal, stimuli.

Mathematics Concepts and Application requires reasoning, in addition to routinized or automatized performance of arithmetic operations. Here one would expect that field independence would enhance performance on the CAT subtest. In the Wmca group, 11 of 17 students are in the lower two quartiles and their mean Block Design score is 8.82. The mean Block Design score for the field independent quartiles is 12.3. The Cmca group follows the well established pattern of the mid-group: increasing field independence yields Block Design scores which increase from 9.24 to 13.06. Unexpectedly, 11 of 18 students in the Smca group also cluster in the first two quartiles of field dependence. Their mean Block Design score is 10.28, which compares with 13.00 for the field independent group. It would appear that arithmetic ability, perhaps facilitated by rote memory, exerts a greater influence in this subtest than does problem solving. Males, it should be noted, account for all of the Smca group save one.

Coding is another clearly sequential task and the field dependence by Reading Vocabulary interaction has a significant influence on Coding scores. For both Wrv and Srv, high Coding scores cluster in the two field dependent quartiles. The reader should recall that sex has significant ($p<0.001$) main effects on Coding scores. The specific ability that facilitates Coding is different than that which facilitates success on the Reading Vocabulary. Girls are clearly superior to boys on the Coding subtest, but they are considerably less successful on Reading Vocabulary. Seventeen percent of the Srv group are girls, yet girls form 37 percent of the research group. At the other end of the scale, girls form 56 percent of the low reading group. Of the nine girls in the Wrv group, eight are in the first two quartiles; in the Srv group, two of the three girls in the group are in the first quartile of field dependence. It is interesting to note, however, that in the Crv group, growing field independence brings increases in Coding scores for girls. Crv boys do not respond in the same manner. Their high Coding scores are at the extremes of the field dependence continuum, but there is in fact little difference in the scores throughout. For the boys in the strong Reading Vocabulary group, field independence, or perhaps simultaneous processing, may interfere with sequential processing; the mean Coding score for the three boys in the high reading-high field independence cell is 6.33. Three is too few cases on which to make any reasonable judgment about a trend in this kind of research if those three cases are the sole reason for making the judgment; however, in this case, the three boys seem to be part of a larger pattern of sequential and simultaneous processing interactions with various subtests and sets of subtests and their results seem to conform to the pattern expected.

The following general patterns seem to have emerged in the examination of field dependence by CAT subtest interactions. First, the middle group improves performance on WISC-R subtests by about four points as field independence increases. Second, the weak group seems to be the most significantly affected by the field dependence construct. Students who perform poorly on those subtests that require sequential processing tend to show stronger scores in subtests which demand simultaneous processing, and they tend to be field independent. Those who perform poorly on the tasks requiring simultaneous processing tend to cluster at the field dependent end of the field dependence continuum. Third, the students who demonstrate superior achievement on CAT subtests requiring problem solving tend to spread more or less evenly across the field dependence contiuum but show higher WISC-R scores at the field independent end if the WISC-R task requires problem solving and, presumably, simultaneous processing. If the superior achievement is on a CAT subtest demanding sequential processing and the WISC-R task demands simultaneous processing, there is a slight tendency for those students to cluster toward the field dependent end of the continuum, and a slight but nonsignificant tendency for higher scores to fall at the field independent end. Fourth, males and females appear to process information differently: males show a tendency to process simultaneously and a preference for figural stimuli relative to females; females tend to process sequentially or successively and show a relative preference for linguistic processing. Finally, male ability and achievement scores are less influenced than are female scores by movement along the field dependence continuum.

There remains but one aspect of the field independence results to be discussed. When the scores of the WISC-R subtests requiring problem solving--Arithmetic, Similarities, Comprehension, Picture Completion, Picture Arrangement, Block Design and Object Assembly--are examined in relation to field dependence, a pattern of scores increasing to the third quartile and then descending to the fourth arises for all but Arithmetic. The pattern is associated most frequently with either one or both of the exceptional groups of the CAT divisions. In only one case, with Comprehension by Reading Comprehension, does the pattern manifest itself with the middle group. And, it occurs with almost equal frequency among the strong and weak groups. It also occurs as frequently when WISC-R problem-solving tasks are paired with CAT problem-solving tasks as when the WISC-R problem-solving tasks are paired with CAT tasks that appear to be primarily sequential or memory tasks. Similarities subtests scores drop between the third and fourth quartiles for females when Similarities is paired with Reading Comprehension, Spelling, Language Mechanics, Language Expression and Reference Skills, while male Similarities scores continue to increase across the continuum. This suggests that extreme field dependence can interfer with information processing in a number of situations. If field independence is truly associated with simultaneous processing, as it seems to be, and if the locus of both is in the right hemisphere, this data supports the suspicions of some researchers that interhemispheric interference may be involved in some manifestations of learning disabililty.

In summary, the interactions examined here suggest the following propostions. (1) Field independence is facilitative of achievement and ability in the absence of unusual strength or weakness in some content/skill area. (2) Males and females are differentially influenced by increasing field independence so that females show greater increases in achievement and ability scores than do males over the same increase in scores measuring field independence. (3) Males and females tend to show differences in processing: males show a preference for and greater ability in figural, nonverbal, and simultaneous processing; females exhibit a preference for and greater ability in verbal or linguistic and successive processing. And (4) in some individuals extreme field independence may mark an inflexibility in processing style that results in lower achievement scores.

In concluding the investigation of field dependence, ability and achievement, it seems appropriate to return to the apparent paradox that stimulated the author's interest in the role of field dependence in learning disabilities: field independent children achieve well in school and score well on the three WISC-R subtests associated with field independence; children in several exceptional groups, e.g., some LD children, autistic children, mentally retarded children, Native children and some others, score well on the PC-BD-OA triad which is associated with field independence but are poor achievers. The children in the exceptional groups mentioned are identified in the literature as field independent, hence, the paradox: field independent children do and do not achieve well. There is nothing in this investigation that utterly dissolves the paradox. There are, however, results which suggest either that field independence does not work uniformly on all people; or that some people who appear to be field independent on evaluation with the instruments used are not, in fact, field independent; or both, that is, field independence works differently among some groups, and some people who have GEFT scores indicating field independence are not field independent.

Researchers accept the field independence construct as being better understood and more unitary than is the case. It is apparent, as remarked in the review of the literature on field dependence, that the children in the exceptional groups mentioned above do not exhibit the behaviors described by Goodenough (1976); Goodenough and Karp (1961); Shade (1983); and Witkin, Moore, Goodenough, and Cox (1977) as characteristic of field independence. It seems unlikely, if the global vs. articulated cognitive style is as suffusive as suggested, that it should only be detectible through tests based on visual perception. And if it is only a visual construct, must the blind then be field dependent? The following is offered for the reader's consideration.

Perceptual speed is a factor in all three of the WISC-R subtests which show a strong relationship with field dependence. Of the three, the PC subtest in which perceptual speed plays the least critical role, i.e., it is the one subtest of the triad for which no bonus points are awarded for speed, has the lightest loading on the field dependence factor for children of the ages studied in this investigation and for older individuals (Goodenough & Karp,1961; Robinson, 1982). It appears that what is meant by perceptual speed is speed of closure; and indeed, Goodenough and Karp note that the three subtests, PC, BD, and OA, have been described both as a Perceptual Speed factor and as a Closure factor as well as a Spatial-Perceptual factor. The essential element in closure seems to be recognition of a gestalt; hence, it is argued that perceptual speed is the speed with which one recognizes a perceptual gestalt.

Gestalt recognition is a key element for success on the Group Embedded Figures Test, as it is in the spatial triad of the WISC-R. It seems likely that speed of closure is related to the scanning aspect of field dependence suggested by Cohen, Berent, and Silverman (1973). When one scans, one scans for something; there is an expectation of finding something recognizable, something with which one has some experience: something which has meaning to the individual. Such a notion ties scanning to the match-mismatch construct of processing suggested earlier in the discussion of results. Individuals who can make rapid visual-perceptual matches can do well on both the GEFT and the Perceptual Speed-Closure-Spatial subtests of the WISC-R. There is ample literature attesting to the fact that many of the same exceptional groups as do well on the spatial tests of the WISC-R have strong visual and visual-spatial abilities in the absence of linguistic abilities. The same abilities that facilitate success on the spatial tests of the WISC-R will facilitate success in the GEFT. The issue is whether such individuals should be identified as field independent. It seems apparent that many, if not most, of the exceptional children who do well on both the spatial triad of the WISC-R and the GEFT do not fit the description of field independent persons developed by Witkin, Goodenough, and their colleagues. Perhaps the term 'pseudo-field independent' needs to be introduced into the literature. The truly field independent person will, on the basis of the intellectual and personality traits described by Witkin et al., be able to manipulate the concept with the same facility as he or she manipulates the percept; he or she is not tied exclusively to the perceptual, as opposed to the conceptual, domain.

The foregoing suggests a resolution to the apparent paradox of field independent children being both poor and successful achievers, but it does not exhaust the construct of field dependence. There are two aspects of the construct that merit comment within the context of this investigation. The first is the relationship of field dependence and simltaneous processing. It has perhaps seemed to the reader that position of this writer is that the field independence pole of the construct is solely identified with simultaneous processing. Such is not the case. In may be, however, that simultaneous processing is identical or nearly identical to the 'articulation' aspect of the construct as described by Cohen et al. (1973), and that it is an essential aspect of the construct. Such a conceptualization is compatible with the description of simultaneous processing offered by Das and his colleagues that was reviewed earlier in this chapter. Simultaneous processing contributes to the 'synthetic'--the putting-together--aspect of field independence. If one accepts the Luria/Das description of cogitive processes, simultaneous processing is not limited to visual stimuli. Their conceptualization allows the concept as well as the percept to enter the realm of field dependence-independence and broadens the construct so that it may apply to linguistic as well as figural stimuli.

The second aspect of the construct that merits consideration is the notion of meaningfulness. The German word Sinngebung, literally 'sense giving', offers perhaps the best rendering of what is meant by 'meaningfulness' in this context. There seems to be an aspect of field independence, as opposed to field dependence, which requires that the perceiver make sense of the incoming stimuli in a particular way. To make sense of something, the sense-maker must objectify his experience of the stimuli and bring it into some relationship, probably some hierarchical relationship, with other experiences of the same genre. The field independent processor's experience is articulated; fitted together with other experience in a hierarchical system. It seems probable, on the other hand, that the field dependent individual's experiences are less articulated and that he or she has less of a tendency to mediate and categorize those experiences. In sum, the field independent person's experience is objectified, mediated, and articulated while the field dependent person's experience is relatively subjective, unmediated and unarticulated.

Again, the notions advanced above do not exhaust the field dependence construct. They do add to understanding the complexity of the concept and provide a rational link between cognitive processes and the resulting intellectual traits manifest by field dependent and field independent individuals.

FIELD INDEPENDENCE--CLINICAL IMPLICATIONS

The results of this investigation suggest that cognitive style, as manifest in the field dependence construct, has a pervasive influence on an individual's intellectual performance. As such, field dependence should be included in any psychoeducational assessment. Field dependent students tend to achieve poorly in many content/skill areas. Many students who fall at the extremes of the achievement measures used in this investigation tend to show either extreme field dependence or extreme field independence. Knowledge of a student's field dependency status will assist in understanding why that student is failing to achieve and may suggest hypotheses to be held in mind in the interpretation of WISC-R profiles.

Perhaps the most important clinical implication to arise from the investigation arises in the differential performance of girls and boys on both the achievement and ability measure relative to their cognitive style. Females, in this study, showed greater changes in performance on the subtests of the WISC-R in response to changes in field dependence than did males. The interactions examined in this chapter suggest that field dependence and its involvement with simultaneous processing has a major influence on how individuals process information, and that the sexes show differential processing preferences. The implication is that male and female WISC-R profiles may require differential interpretations, i.e., a profile for a highly field independent female may be similar in its pattern of peaks and valleys to that of a mid-field male, but the two profiles may say somewhat different things about the nature of that girl's and that boy's learning difficulty. The further implication is that the profiles described in Chapter 6 would have greater diagnostic value if separate profiles for strength and weakness in each of the CAT subtests and for each quartile of field dependence had been developed for each sex.

The clinical implications of field dependence are, perhaps, somewhat less imperative because the construct is less well understood than it might be. The problem of 'pseudo-field independence' is a case in point. How are the "truly" field independent, those who can deal with conceptual as well as perceptual material with an articulated or differentiated style to be discriminated from the 'pseudo-field independent' who can deal efficiently with perceptual material but who do not manifest the other traits characteristic of differentiated or articulated learners?

There is a need for a new research instrument that will sort out field independence and ‘pseudo-field independence’. Additionally, there is ~~a need for~~ a clinical instrument which will distinguish a group of people who might be called ‘field selectors’--persons who can operate either as field dependents or field independents according to the demands of the task. The present instruments seem to make the tacit assumption that those labelled field independent are field selectors. What is required is an instrument on which field dependents and field selectors score well while field independents, or perhaps more precisely, pseudo-field independents do poorly. Such an instrument would enhance understanding of field dependence and its implication for achievement and manifestation of ability.

CONCLUSION

REVIEW OF THE PURPOSE OF THE STUDY

Two considerations were major influences in determining the form of this study. One was a desire understand better the nature of the learning disabilities seen almost daily in the classroom and the counselling office. The second was a response to the challenge from researchers in the field of learning disabilities and psychoeducational assessment to begin to look for homogeneous groups of learning disabled children within the larger heterogeneous group. It was hypothesized that the WISC-R profiles for different groups of learning disabled children would differ according to the specific content/skill area in which there was a learning deficit, and that the child's cognitive style as described in the field dependence construct would in part determine the nature of the disability and the resultant WISC-R profile. The desired outcome of the study was improved diagnostic procedures that would lead, in turn, to more appropriate approaches to remediation of specific learning problems. The emphasis in the study is, however, on differential diagnosis and not on remediation.

OUTCOMES OF THE STUDY

The study identifies five profiles: Strong Language, Weak Reading, Strong Mathematics, Weak Mathematics, and Weak Spelling. The Weak Language Use or Language Application profile which was discussed may not be recognizable in day-to-day practice and may have limited diagnostic value. Whether the other profiles will have diagnostic value in the counsellor's or school psychologist's office remains to be seen. The Strong Language and Weak Mathematics profiles and the Strong Mathematics and Weak Reading profiles may not be separable in the "field"; although, the very consistent depression of Block Design in the Strong Language may be diagnostic when the rest of the profile fits. Profiles to be compared to those described in this study must be evaluated on the basis of the similarities of the peaks, valleys, and plateaus and not on the basis high scores or low scores relative to the population means.

There was little found in the analyses done th~~at sheds~~ new light on the relationship of Verbal-Performance IQ differences to either achievement or learning disabilities; however, interesting results occur with other subsets of WISC-R scores. Two groups, Strong Mathematics and most field independent quartile, showed Verbal-Performance differences significant at the $p<0.01$ level, and in each case, as would be anticipated, the Performance IQs were greater than the Verbal IQs. The common quality shared between Strong Mathematics and a high level of field independence is a preference or at least a facility for processing nonverbal material. The division of the CAT Mathematics Computation subtest produced a second unique result. Only the Weak Mathematics profile shows a "pure"

Third Factor deficit. 'Pure' is used here to distinguish the Third Factor from the ACID factor. The results of this study show the Third Factor to be strongly associated with sequential tasks or weakness in sequential tasks and with field dependence (as differentiated from field independence), and on that basis, it is suggested that the Bannatyne categorization of the subtests as a measure of sequential ability has greater utility than does the conceptualization of the tests as a measure of attention and concentration. The more inclusive "ACID" profile appears with weak Mathematics Computation, strong Reading Vocabulary, and strong Reference skills. A "VIDA" profile is manifest with strong Reading Comprehension, strong Language Expression, strong Language Mechanics, and, on the division of scores by sex, the female profile.

Field dependence or independence is associated with achievement or lack of achievement at the 95 percent or greater level of certainty in all the CAT subtests except Spelling and Language Mechanics. It is correlated at the same levels of significance with all three WISC-R IQ scores and with four of the WISC-R subtests. In multiple analysis of variance results examining the influence of the CAT divisions and field dependence on WISC-R subtest scores, field independence shows significant ($\underline{p} \leq 0.05$) main effects on the scores obtained on Information, Similarities, Comprehension, Picture Completion, Block Design, and Object

Assembly. Anova shows interaction effects for Similarities by Spelling; Picture Completion by Reference Skills; Picture Arrangement by Reference Skills; Block Design by Mathematics Computation, Mathematics Concepts and Applications, and Reference Skills; Object Assembly by Mathematics Computation; and Coding by Reading Vocabulary. And, in most of the above relationships, the "average" group's scores increase about four points between the field dependent and field independent quartiles. The results suggest that field dependence is an important construct, and that it should be included in psychoeducational assessment. The field dependence results should play an important role in developing individual educational plans for remediation.

This study has identified an number of constructs which seem essential to the understanding of the relationship between WISC-R scores and achievement. Those constructs include sequential or successive processing vs. simultaneous processing; meaningful vs. non-meaningful stimuli; verbal vs. symbolic vs. figural material; reasoning vs. memory; analysis vs. synthesis; expressive vs. receptive language; and field dependence vs. field independence. Another construct, automatization vs. preceptual-restructuring, comes out of the work of Vogel, Broverman and Klaiber (1968) and EEG analysis. The construct appears to be related aspects of both the field dependence and successive-simultaneous processing constructs and may be useful if it can be brought outside the EEG laboratory. The successive vs. simultaneous construct seems, in the light of this research, more descriptive than a sequential vs. global construct. A major difference between the two constructs is question of into which hemisphere analytical ability is to be "placed".

The role of lateralization of function of the two hemispheres has not been developed. The hypothesis that field independence is a function of dual differentiation in the right hemisphere and that a high level of differentiation is accompanied, presumably in normally functioning individuals, by a high level of intergation has been suggested as useful construct with which to explain some of the results obtained. Failure of lateralization or incomplete lateralization and/or lack of integration of the function of the two hemispheres are constructs which yield a conceptual framework that would account for a number of the results in a consistent way. Nothing in the results obtained mediates against the Luria/Das position that sequential and simultaneous processing abilities lie in both hemispheres. The decline of some WISC-R scores for students, especially exceptional students, in the fourth quartile of field independence is, if one accepts a right hemisphere location for field independence, consistent with the suggestion of right hemisphere interference in language processing. Differential response to field dependence or independence between males and females is also consistent with suggestions that the sexes lateralize differently or, at least, lateralize at different developmental rates.

LIMITATIONS OF THE STUDY

The question of the LD status of each child is in part a limitation. While the approach taken mediates against the possibility that children who are not truly learning disabled are included in the weak content/skill groups, data on the status of each child and the preceived nature of his or her disability would facilitate follow up and validation of the observations made. A related concern is the question of how broadly applicable are the results obtained. The study would benefit from comparison with a random sample of children assessed on the WISC-R. Again, the effects of the selection procedures are somewhat mediated by the methodology. The eighty percent of children in each group who fall between the extremes do provide a comparison group if not a control group.

The size of the sample is also a limiting factor. As is indicated in the body of the report, despite modifications to the research design to insure an adequate number of cases in each cell, some cells in the interaction studies were empty or contained one or two individuals. Some three level interactions were rejected by the computer program because of empty cells.

The necessity of compromising the parameters identifying levels of field dependence was also a limitation. Students placed according to the quartiles determined in the junior high school standardization sample may have performed differently.

Results obtained from the field dependence investigations also suggest that a larger sample would have been desirable. The differential effect of field dependence on male and female WISC-R profiles was more profound than was anticipated on the basis of the literature available. While the literature reports small but significant male-female differences in field dependence, there is little in the literature that would lead an investigator to anticipate the differential impact of field dependence on the subtest scores of both the CAT and WISC-R, especially among the exceptional groups. It would have been desirable to have developed student profiles as was done in this study but by sex as well. To have effected such a separation would have required an even larger number of students, especially of female students to have insured that each cell would have had a reasonable number of cases.

Finally, some WISC-R scores were obtained nearly three years prior to the administration of the GEFT and CAT. Given the results of this study that closely link performance on a number of the WISC-R subtests to field independence, plus the finding, both in the literature and in standardizing the GEFT with a junior high school sample, that field independence increases with age, and that it is changing with the age groups included in this research, it would have been preferable to have had all the WISC-R administered closer in time to the administration of the GEFT. It would have been desirable to have groups divided and collected on the basis of age and to have done a separate but parallel study for each age group. In fact, the data for this study was collected and arranged by age, but to have tried to include yet another division would have reduced the cases per cell to unacceptable levels and generated an even more complex matrix than the one created in this investigation. This investigation looked at the interactions of four levels of field dependence across eight CAT subtests of three divisions each in relation to eleven WISC-R subtests.

IMPLICATIONS FOR FURTHER RESEARCH

A number of possibilities flow from the foregoing discussion. It would be useful to replicate the study on a larger number of students drawn through a random sample. A series of studies designed to explore WISC-R and field independence relationships at different ages would also be useful and might suggest not only approaches to remediation for different age groups but also age-appropriate teaching strategies for children at different stages of field dependence. The relationship between specific learning disabilities and field independence should be explored.

There are at least three constructs that seem to offer considerable promise in understanding the nature of information processing and those constructs appear to be interwoven. They are field dependence-independence, successive-simultaneous processing, and automatization-perceptual restructuring. These, while related, are not synonymous, and their sorting out can contribute significantly to understanding how information is processed. The nature of the field dependence construct and its role is learning disabilities requires a similar "sorting out". The notion of 'pseudo-field independence' requires further examination. Can field dependence/field independence be sorted out using concepts as well as percepts? Another major and related question is "Can field dependent people do things that field independent people cannot do?". This question has major implications for teaching and learning. There is a body of intercultural research that suggests that the style of information processing adopted is a function of either racial or cultural differences. This research should be evaluated and integrated into psychoeducational research.

Finally, there are very specific projects suggested by this research. One such project is intercultural. The question to be dealt with asks, "Is the relationship between spelling and field dependence observed in this investigation a function of the language to be spelled or a function of information processing?". It seems likely that conceptual processors will achieve better spelling scores in a language that is either consistently phonic or consistently ideographic. The second "specific" investigation is to examine the relationship between field independence and Digits Backwards. The more field independent students should be able to restructure the stimulus field and should have greater success on Digits Backwards than do field dependent students.

This investigation is concluded. In its conclusion, as always in research, new questions, and perhaps more interesting questions, are suggested.

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